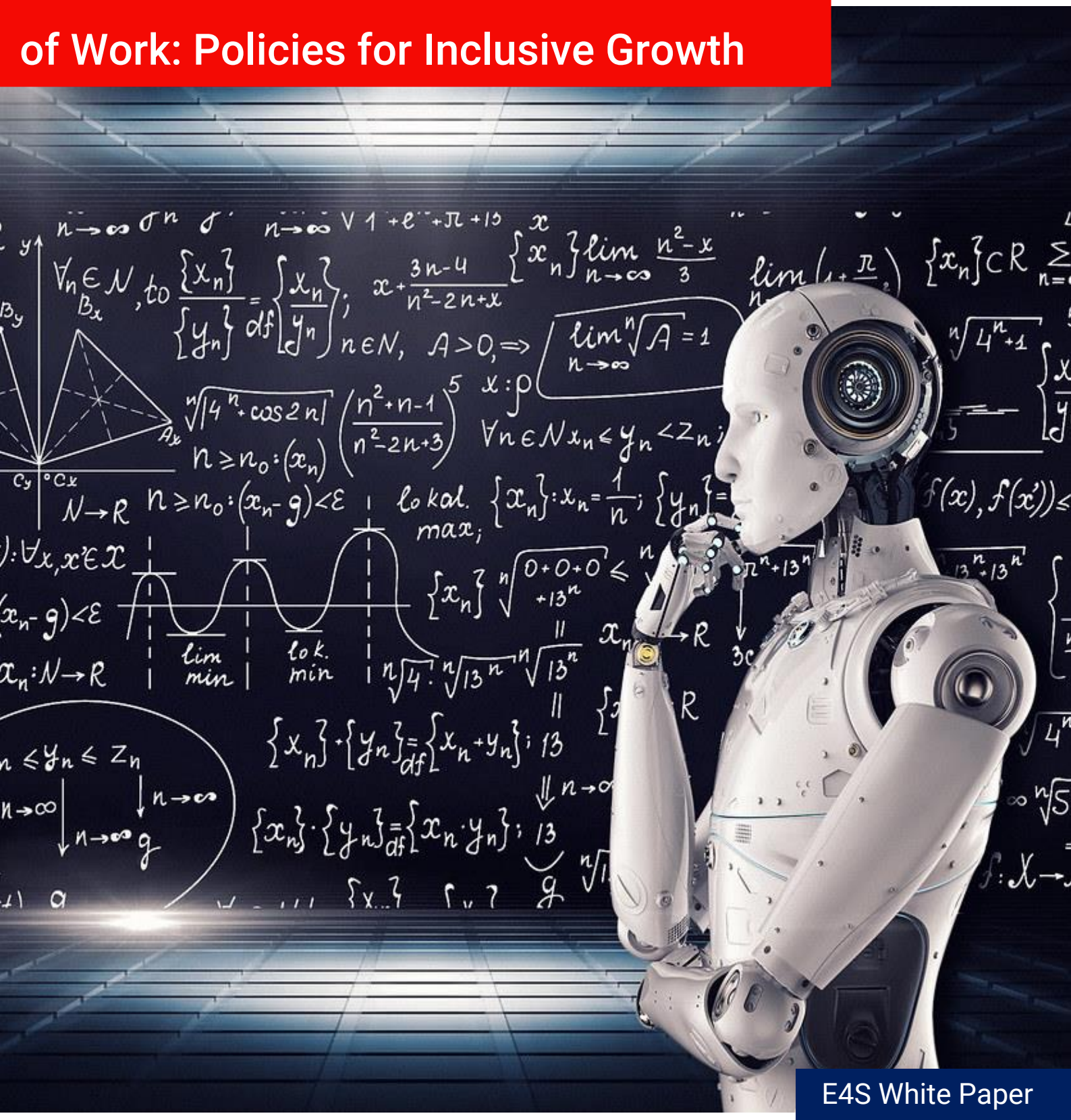
Automation Technologies and the Future of Work: Policies for Inclusive Growth



E4S White Paper

November 2021

Automation Technologies and the Future of Work:
Policies for Inclusive Growth

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First version: March 2021
This version: November 2021

E4S acknowledges financial support from the University of Lausanne, IMD, and EPFL.

The project was conducted in the context of a partnership with the Geneva Science and Diplomacy Anticipator (GESDA).

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Executive Summary

English

There is a growing concern in public discussions that automation could soon make human labor obsolete, depriving workers from their livelihood and sense of belonging while enriching capital owners and powerful tech companies.

Building on recent advances in the economics literature, this report aims to delineate the state of knowledge on the impact of machines on the future of work and to offer guidance on how to prepare societies for the arrival of intelligent machines.

Our report highlights that automation technologies will significantly change our economies but will likely not – at least in the foreseeable future - make human labor obsolete. Yet, the transformation and displacement of traditional tasks and occupations have the potential to generate significant disruptions of labor markets with implications for wellbeing, and the distribution of incomes.

From a policy point of view, a just and inclusive transition towards increased use of automation technologies requires a stronger involvement of governments. Besides a demand for policies that promote more equal labor market outcomes, there is a need for a more equal sharing of the gains of economic growth. Steering technology towards labor augmenting innovations and correcting the imbalance in the taxation of capital and labor are key policy measures that would set the right conditions and incentives for firms to create jobs rather than to replace humans with machines. Moreover, to prepare workers for new tasks and facilitate their adaptation to a changing workplace, smart education policies are needed.

Français

Le débat public porte de plus en plus la crainte que l'automatisation ne rende bientôt le travail humain obsolète, privant les travailleurs de leurs moyens de subsistance et de leur sentiment d'appartenance tout en enrichissant les détenteurs de capitaux et les puissantes entreprises technologiques.

S'appuyant sur les récentes avancées de la littérature économique, ce rapport vise à délimiter l'état des connaissances quant à l'impact des machines sur l'avenir du travail et à orienter la réflexion sur la façon de préparer les sociétés à l'arrivée des machines intelligentes.

Notre rapport souligne que les technologies d'automatisation changent considérablement nos économies mais ne rendront probablement pas - du moins dans un avenir prévisible - le travail humain obsolète. Cependant, la transformation et le déplacement des tâches et des professions traditionnelles sont susceptibles d'entraîner des perturbations importantes sur le marché du

travail, avec des répercussions sur le bien-être et la répartition des revenus.

D'un point de vue politique, une transition juste et inclusive vers une utilisation accrue des technologies d'automatisation nécessite une implication plus forte des gouvernements. Outre la nécessité de politiques favorisant des résultats plus égalitaires sur le marché du travail, il faut aussi assurer un partage plus équitable des gains de la croissance économique. Orienter la technologie vers des innovations qui favorisent le facteur travail et corriger le déséquilibre existant dans la taxation du capital et du travail sont des mesures politiques clés pour assurer que les conditions-cadres et les incitations poussent les entreprises à créer des emplois plutôt qu'à remplacer les humains par des machines. Pour préparer les travailleurs à de nouvelles tâches et faciliter leur adaptation à un lieu de travail en mutation, des politiques d'éducation intelligentes sont elles aussi indispensables.

Deutsch

In der öffentlichen Diskussion wächst die Sorge, dass die Automatisierung die menschliche Arbeit bald obsolet machen könnte und damit den Arbeitern ihre Lebensgrundlage und ihr Zugehörigkeitsgefühl entzieht, während Kapitaleigner und mächtige Tech-Unternehmen immer Reicher werden.

Gestützt auf die jüngste wirtschaftswissenschaftliche Forschung stellt dieser Bericht den Stand der Wissenschaft über die Auswirkungen von Maschinen auf die Zukunft der Arbeit dar und zeigt auf, wie sich Gesellschaften auf die Ankunft intelligenter Maschinen vorbereiten können.

Unser Bericht betont, dass Automatisierungstechnologien unsere Volkswirtschaften erheblich verändern werden, aber wahrscheinlich - zumindest in absehbarer Zukunft - die menschliche Arbeit nicht überflüssig machen. Dennoch haben die Veränderung und die Verdrängung traditioneller Aufgaben und Berufe das Potenzial, erhebliche Beeinträchtigungen auf den Arbeitsmärkten herbeizuführen, die Auswirkungen auf Wohlstand und Einkommensverteilung haben.

Aus politischer Sicht erfordert ein gerechter und inklusiver Übergang zum vermehrten Einsatz von Automatisierungstechnologien eine stärkere Beteiligung der Regierungen. Neben Instrumenten zur Angleichung der Ergebnisse auf dem Arbeitsmarkt, besteht eine Notwendigkeit Einkommensgewinne gleichmässiger zu verteilen. Die Lenkung der Technologie in Richtung arbeitserweiternder Innovationen und die Korrektur des Ungleichgewichts bei der Besteuerung von Kapital und Arbeit sind wichtige politische Maßnahmen, die die richtigen Bedingungen und Anreize für Unternehmen herbeiführen, um Arbeitsplätze zu schaffen, anstatt Menschen durch Maschinen zu ersetzen. Dazu ist eine intelligente Bildungspolitik erforderlich, die Arbeitnehmer auf neue Aufgaben vorbereitet und ihre Anpassung an einen sich verändernden Arbeitsplatz erleichtert.

1 Introduction

Automation technologies such as artificial intelligence (AI), robotics and other computer-assisted technologies have the potential to radically transforming our economies, societies, and lives. There is a growing concern in public discussions that automation could soon make human labor obsolete, depriving workers from their livelihood and sense of belonging while enriching capital owners and powerful tech companies. The last decades of globalization constitute a warning signal: our societies must better anticipate the disruptions that the economic and technological evolutions are provoking. The societal and political consequences when large fractions of the population are not sharing the gains of the ongoing transformations are devastating.

THE LAST DECADES OF GLOBALIZATION CONSTITUTE A WARNING SIGNAL: OUR SOCIETIES MUST BETTER ANTICIPATE THE DISRUPTIONS THAT THE ECONOMIC AND TECHNOLOGICAL EVOLUTIONS ARE PROVOKING.

To prepare workers for the arrival of intelligent machines, and to buffer potential negative impacts that some parts of the labor force will experience, societies need to anticipate and be prepared to act. There is a growing consensus in the economics literature that the state needs to take on many more responsibilities in this process.[1] Rethinking the welfare state, redirecting technological change, designing modern industrial policies, and providing good jobs besides redistributing incomes are some policy suggestions that can determine whether AI and similar technologies lead to the greatest benefit for every part of society and to an equitable distribution of their gains. Without policies for inclusive growth that allow workers to lead fulfilling lives, economic inequalities are at risk of growing, with far-reaching consequences for social cohesion and the functioning of democracy.

This report aims to delineate the state of knowledge on these issues and thus to offer guidance on how to prepare societies for the arrival of intelligent machines. It builds on recent advances in the economics literature. In section 2 we ask whether this time might be different. Section 3 discusses how automation technology could affect the future of labor, both from a theoretical and empirical perspective. Section 4 provides a menu of policy solutions to prepare societies for the increased use of automation technologies.

[1] There is also a growing view that the private corporate sector should evolve to do a bigger share of the work by focusing less narrowly on maximizing shareholder value and accepting responsibility for value creation in favor of all its stakeholders.

2 Is this time different?

Citizens are confronted daily with headlines such as "Prepare For 'Robomageddon'"[2], "Robots to replace up to 20 million factory jobs' by 2030"[3], and "The pandemic is speeding up automation, and 85 million jobs are on the line"[4]. Uncertainty is fueled by estimates of the impact of technological change on labor markets that vary widely. Some studies assert that almost half of the jobs of the US Economy risk to be automatized (Frey and Osborne, 2017), while others estimate that "only" about 15% of global jobs will be replaced by the year 2030 (McKinsey Global Institute, 2018).

A look back in history suggests that concerns about technological unemployment might be partly unwarranted. Despite two hundred years of innovation in automation technologies, human labor did not disappear. Earlier waves of automation, for example during the Industrial Revolution, brought along large gains in productivity and living standards. In the short run, however, these technologies led to significant economic and social disruptions. The displacement of some traditional occupations by machines was followed by economic hardship and social unrest, most prominently the anger of the Luddites against the mechanization of textile industry at the beginning of the 19th century. At the same time, technologies created new employment opportunities in entirely novel industries, such as in car manufacturing or IT.

> UNLIKE PREVIOUS WAVES OF AUTOMATION TARGETED AT REPLACING HUMAN MUSCLE POWER AND BRAIN CAPACITY, NEW TECHNOLOGIES SUCH AS AI HAVE THE POTENTIAL TO REPLACE HUMAN INTELLIGENCE ENTIRELY.

Is this time different? It could be, because unlike previous waves of automation targeted at replacing human muscle power and brain capacity, new technologies such as AI have the potential to replace human intelligence entirely. If intelligent machines outperformed humans in every task, the future for human labor looks rather gloomy. While this is for the moment just a hypothetical scenario, it remains that automation is likely to dramatically alter the tasks performed by humans, leading to substantial changes in the type and content of occupations and the type of worker skills being valued. Major disruptions to labor markets, the economy, and possibly to society at large, are to be feared. In fact, automation technologies are already leaving profound impacts on certain occupations: industrial robots are today widely used in manufacturing instead of assembly line workers,

[2] Forbes, February 10, 2020.

[3] BBC, June 26, 2019.

[4] CNN, October 21, 2020.

and self-service kiosks are seen in many supermarkets. In the United States the number of industrial robots in manufacturing increased from 2.5 industrial robots per thousand workers in 1993 to 20 per thousand workers by 2019 (Acemoglu and Restrepo, 2020b).[5]

3 How will AI affect the future of labor?

The extent of labor market disruptions caused by automation technologies will depend on how fast novel technologies will be developed and adopted, as well as on the quantity and types of human tasks that machines will be able to perform (Korinek and Stiglitz, 2017).

> ABOUT ONE-THIRD OF ECONOMISTS AGREED THAT TECHNOLOGY WOULD INCREASE UNEMPLOYMENT, WHILE ONE-THIRD DISAGREED, AND ONE-THIRD WAS UNDECIDED.

Economists are divided about the effects of AI on the future of work. For example, in 2017 the IGM Chicago Booth panel asked leading economists whether an increased use of AI and robotics will lead to higher long-term unemployment.[6] About one-third of economists agreed that technology would increase unemployment, while one-third disagreed, and one-third was undecided. This uncertainty about the labor market consequences of AI stems partly from the uncertainty about which tasks new technologies, in particular AI and machine learning (ML), will be able to perform in the future.[7] AI and ML excel today in routine tasks such as classifying and making predictions based on a predefined set of rules and large datasets from which they learn, for example recognizing faces or predicting insurance claims. Whether and when AI will reach general intelligence, i.e., human-level intelligence that allows machines to perform any task humans can do, is yet unknown. AI experts believe that machines will be better at humans in many tasks in the next decade. According to Grace *et al.* (2018) there is a 50% chance that machines will reach general artificial intelligence in about 45 years.

Based on today's knowledge about the ability of intelligent machines, which tasks and jobs will likely be sheltered from automatization? Machines will have difficulties to compete with workers in tasks that are particularly "human": these are tasks that demand a high level of creativity, critical thinking, and social intelligence. In general, jobs that require caring, sharing, understanding, creating, innovating, and managing will be in high demand (Baldwin, 2019).

[5] Besides a growing use of automation, another worrying trend in the last decades has been the decline of research productivity that could lead to too little technological progress in the future (see Bloom *et al.*, 2020).

[6] See https://www.igmchicago.org/surveys/robots-and-artificial-intelligence/.

[7] There is "no widely shared agreement on the tasks where ML systems excel, and thus little agreement on the specific expected impacts on the workforce and on the economy more broadly." (Brynjolfsson and Mitchell, 2017).

Already throughout the last decades, employment and wage growth was particularly strong in jobs that demand a high degree of social skills, such as for teachers, managers, and nurses (Deming, 2017).

50%

THE CHANCE THAT MACHINES WILL REACH GENERAL ARTIFICIAL INTELLIGENCE IN ABOUT 45 YEARS.

3.1. Theoretical considerations

Today, innovations in AI and many other new technologies are heavily targeted towards replacing human tasks. There is therefore little doubt that automation technologies will displace an increasing number of traditional tasks and jobs. These are not necessarily only tasks at the bottom of the skill distribution. While robots and AI technologies are taking over tasks in jobs that are intensive in routine and manual tasks performed by low and medium skilled workers, AI and ML are also able to perform tasks of highly skilled professions (e.g., analyzing medical images traditionally done by radiologists). The effect on total employment is theoretically ambiguous. On the one hand employment decreases as some jobs disappear. On the other hand, the productivity increase brought by automation technologies will lower consumer prices and increase incomes. Higher incomes spent on goods and services, together with the possibility that automation creates new, yet unforeseeable tasks and jobs by making it possible to profitably offer new goods and services, could lead to an increase in labor demand and a reinstatement of labor (Acemoglu and Restrepo, 2019). Total employment will therefore depend on the relative magnitudes of the displacement and reinstatement effects. The McKinsey Global Institute (2018) estimates that globally the number of new jobs created will more than offset job destruction by automation. However, this creates important social challenges that need to be recognized, as novel employment opportunities might not emerge in the location of disappearing industries, and new jobs will not necessarily be suitable to the displaced workers.

A particular case of concern are technologies that replace labor but that only marginally increase productivity. Acemoglu and Restrepo (2019) label these technologies "so-so" technologies. They bear the risk of excessive automation: while employment declines because of the displacement of labor, its fall is not matched by a reinstatement of workers of similar size, because these technologies increase productivity only little. Recent worrying trends in employment and productivity could be indicative of the prevalence of "so-so" technologies: alongside the increased use of automation and AI in recent years, many developed economies have experienced a stark decline in the labor share and a stagnating demand for labor. Moreover, the increased use of automation technologies did not show up in productivity statistics: productivity growth has been weak since the turn of the millennium (Acemoglu and Restrepo, 2019).[8]

[8] The decline in the labor share has not only been observed in the US, but in several other OECD countries (see OECD report "The Labour Share in G20 Economies", 2015). See also Autor, Dorn, Katz *et al.* (2020).

"SO-SO" TECHNOLOGIES DISPLACE WORKERS BUT ONLY INCREASE PRODUCTIVITY MARGINALLY.

3.2. What does the data say?

Do robots and automation technology replace human labor? Economists have intensively studied the empirical relationship between the adoption of automation technologies, in particular robotics, and labor market outcomes in recent years. The findings vary significantly across studies, depending on the levels of analysis (markets, firms, workers) and settings.

Several studies find that total employment in a labor market does not react to the adoption of robots, but that there are sizable transformative effects: while the share of low-skilled manufacturing workers declines, it is compensated by a growth in the service sector (see for example Graetz and Michaels, 2018; Dauth *et al.*, 2018; Mann and Püttmann, 2020). On the contrary, Acemoglu and Restrepo (2020b) and Acemoglu, Lelarge, and Restrepo (2020) document negative effects of robots on labor market employment in the US and France. At the firm-level, the adoption of robots has been found to increase outcomes such as productivity, profits, sales, as well as total employment for firms that adopted robots, compared to competitor firms without automation that shrink (Aghion *et al.*, 2020; Koch *et al.*, 2021). Few studies have researched similar effects for AI technologies. An exception is Webb (2020), who measures AI exposure of tasks from the texts of US patents. His results suggest that AI will not target tasks in low and medium skill occupations, as it is the case for robots and computer software, but tasks associated with high-skilled jobs. The displacement of high-skilled tasks could imply some decline in economic inequalities.

Overall, our review of this literature suggests that it is premature to draw definitive conclusions. While automation will probably not make work obsolete, what is sure is that it will significantly transform labor markets, eliminating some tasks and jobs and creating new ones that are potentially very different. Workers that enter the labor market will be required to learn different skills than previous generations. Lifelong learning will become important for those midcareer workers whose tasks will change within an occupation, and for those who move to entirely different occupations because of automation.

3.3. Market forces and the direction of technological development

The direction of research in AI has so far been heavily focused on automatizing tasks traditionally done by humans, with the goal of creating a general artificial intelligent technology. But AI can also augment human labor, thereby creating new tasks for workers, increasing their productivity and overall labor demand. Can market forces be relied on for the development of labor augmenting AI? Acemoglu and Restrepo (2020a) advance several arguments for why this is unlikely to be the case.

First, externalities in the market for innovations lead to a level of innovation below the social optimum, as the social value of labor augmenting AI exceeds the private market value for innovators (who do not naturally take into account both the social benefit of providing good jobs, nor the social cost of putting to market technologies that

destroy jobs). Second, new innovators have the tendency to follow existing technology paradigms. If these are focused on automation, new entrants will have incentives to design automation technologies, too. Thus, the market might fail to produce an optimal level of diversity in research and innovation (Acemoglu, 2011). In fact, the development of AI is dominated by few tech leaders, such as Amazon, Apple, and Google, that invest billions of dollars in AI (McKinsey Global Institute, 2017).[9] Third, if the norms and values of tech leaders are biased towards labor-saving automation, they will also influence the next generation of University graduates, and increasingly also the curricula of University education. Finally (and more objectively), tax codes in many advanced economies strongly favor capital investment, justifying automating even when machines are only marginally more productive than human labor (Acemoglu and Restrepo, 2020a; Acemoglu, Manera, and Restrepo, 2020). Left to market forces alone, it is therefore unlikely that a socially optimal amount of labor augmenting innovations will be created and adopted.

3.4. Consequences for inequality

Middle-skilled workers performing routine tasks have been particularly affected by automation technologies (Autor *et al.*, 2019). Industrial robots displaced assembly line workers, self-checkout machines took the job of cashiers in supermarkets, and AI technologies such as chatbots started more recently to take over tasks of customer service employees. The decline of middle skilled jobs due to automation and other factors such as globalization has been experienced by many high-income countries.

MIDDLE-SKILLED WORKERS PERFORMING ROUTINE TASKS HAVE BEEN PARTICULARLY AFFECTED BY AUTOMATION TECHNOLOGIES.

While jobs for middle-skilled workers declined, jobs for highly skilled workers, and a to more limited extent low-skilled workers, increased, leading to a growing polarization of the labor market (Autor, 2015). The gap in wages grew, too, as wages at the top of the skill distribution rose in line with productivity increases in the last 30 years, while wages of the average worker decoupled from productivity and largely stagnated. To a large degree wages of highly skilled workers rose because of skilled-biased technologies, in particular ICT. The growing incomes at the top and the sluggish incomes at the bottom increased income inequality greatly in

[9] According to research by the McKinsey Global Institute (2017), tech leaders were responsible for three-fourths of the total worldwide investment in AI in 2016, most of which went into R&D.

Box-1: A future without radiologists and translators?

Two occupations that have been frequently taken as examples of how automation will change jobs are **radiologists** and **translators** (see Agrawal *et al.*, 2019a, 2019b).

Machine learning algorithms assist doctors by analyzing medical images and by predicting abnormalities that **human radiologists** interpret, thereby increasing the speed and decreasing the cost of medical scans. While faster analysis of scans decreases the demand for radiologists if the demand for scans remains constant, the cheaper price per scan could lead to an increase in the number of scans and thus in the demand for radiologists. The total effect therefore is ambiguous, it depends on the relative magnitudes of the displacement and productivity effects, even if the analysis of medical scans is completely performed by a machine. In such a case, as radiologists perform many different tasks, the productivity increase in medical image analysis could increase the demand for other complementary tasks performed by human radiologists.

Machine translation can automatically translate text and speech from one language to another. A direct effect of the adoption of this technology is a reduction in demand for **human translators.** By contrast to the previous example one can argue that translators' main task is translating and that they perform a smaller number of complementary tasks than radiologists. Thus, while the cost reduction in translations is likely to increase demand for translation services notably in industries that operate in multilingual environments, firms in international trade or in the travel industry, it is less likely that the demand for human translators can be prevented from decreasing.

developed countries (Bhatt *et al.*, 2020). Another important reason why inequality could grow with an increased use of automation technologies is that capital owners - who are already richer - will see their incomes rise (Agrawal *et al*., 2019b). The flip side of the decreased labor share is a growing share of incomes going to capital in recent decades. As capital gains are taxed more favorably than labor incomes in most advanced economies (Scheuer, 2020), disparities in income and wealth will likely grow. In the very long run it is possible that human enhancement technologies become available that enhance human mental or physical capabilities. Such technologies will presumably be affordable only to the richest members of society. They could therefore lead to even more dramatic increases in inequalities (Korinek and Stiglitz, 2017).

A GROWING SHARE OF INCOMES HAVE BEEN GOING TO CAPITAL IN RECENT DECADES.

Labor markets transformations also affect the spatial distribution of economic prosperity within countries. For example, high-skilled jobs cluster in urban areas while middle-skilled work, such as manufacturing employment, is relatively more important in rural location. In the USA the decline in middle-class jobs resulting from automation and globalization led to significant spatial economic disparities in recent years. The geographical segmentation is not only economic, but it manifests itself similarly along cultural and political dimensions, separating a cosmopolitan elite from left-behind working-class communities, and threatening the social fabric (see Rodrik, 2019b).

The decline of the middle class and the rise in inequality have been linked to the recent surges of political polarization, populism, and authoritarianism in many advanced countries (Voorheis *et al.*, 2015; Bhatt et al., 2020). There is evidence that the loss of manufacturing work resulting from international trade – in many ways similar to automation - increased polarization in the US (Autor, Dorn, Hanson *et al.*, 2020) and the vote shares of right-wing populist politicians in Germany (Dippel *et al.*, 2020). Moreover, the adoption of industrial robots appears to have favored the election of nationalist politicians across European (Anelli *et al.*, 2019). Economic inequality spurs political inequality. Wealthy individuals and corporations can have important influence on policy choice in the realm of social welfare and labor markets through lobbying and campaign financing.[10]

Besides inequalities within developed countries, how will global inequalities, that have been declining since decades, be affected by automation? In recent decades, large parts of manufacturing have been moved from high-income nations to nations abundant in cheap, low-skilled labor, particularly to Asia, making China the factory of the world. The advent of AI technologies, such as robots in manufacturing or 3D printing, could make outsourcing less valuable. As automation technologies decrease the demand for low-skilled labor, less jobs will be shifted to developing countries, and some jobs might even be moved back to developed countries (Rodrik, 2018). Reshoring will hurt especially low-income countries where large parts of the labor force is unskilled and skilled labor is scarce. On the other hand, the emergence of computer assisted technologies and AI could lead to the migration of white-collar office jobs (e.g., in service) to low-wage nations. Technological innovations, such as video calls and machine translation, decrease the importance of the physical presence of workers and the language they master (Baldwin, 2019). White-collar jobs that are relatively skill-intensive will likely be outsourced to middle-income rather than low-income countries. The global poor are therefore at risk of being largely excluded from the benefits of automation technologies. Consequently, the decline in global inequalities could slow down, or worse, economic disparities across countries could grow again.

[10] Over the last decade from 2010 – 2019, the seven biggest tech firms including Amazon, Google, Twitter, and Uber spent together about half a billion dollars on lobbying in the US. (Washington Post, January 22, 2020. *https://www.washingtonpost.com/technology/2020/01/22/amazon-facebook-google-lobbying-2019/).*

4. Policy recommendations

In light of the challenges posed by globalization and automation technologies, a new consensus has emerged in the economics literature that the state needs to be much more strongly involved in addressing these issues. To counter potential adverse transitional effects of automation and prepare the labor market for new technologies, economists largely agree that governments should take on more responsibilities in the realm of labor market institutions, social welfare policies, and education. Labor-replacing automation technology is not a destiny. Societies can choose which technology should be invented, used, and how the gains should be shared. Government policies and regulations should be put to work with that goal in mind. These policy solutions placing a renewed emphasis on the role of the state are no less than a rebuilding of the welfare state into a welfare state 3.0 that promotes inclusive growth (Acemoglu, 2020a).[11]

A NEW CONSENSUS HAS EMERGED IN THE ECONOMICS LITERATURE THAT THE STATE NEEDS TO BE MUCH MORE STRONGLY INVOLVED.

A strategy of inclusive growth should move away from the paradigm "grow first, redistribute later" and put greater emphasis on the pre-production and the production stage so that workers are included in the economic process (see OECD Framework for Policy Action on Inclusive Growth, May 2018).[12] Pre-production phase policies prepare workers with the necessary endowments and skills to enter the labor market, by investing in education, infrastructure, and health care, and more strongly so in lagging regions. Production phase policies target the quantity and quality of jobs so that increases in productivity are shared among all workers. Retraining and lifelong learning programs are crucial components to facilitate the transition of workers into new occupations.

[11] As policy making often responds only slowly to societal challenges, recent research in business and management science has advocated for a changing role of businesses from profit-maximizing enterprises towards providers of socially valuable solutions that internalize parts of the externalities that they create (see Mayer 2018, 2019). The idea of the "purposeful business" implies that firms redefine their "purpose" and aim at solving problems of societies profitably, such as in the realm of the environment or the creation of socially beneficial technologies. Instead of only focusing on maximizing profits and shareholder value as postulated in the Friedman doctrine 50 years ago, corporations should focus more on stakeholders. The move towards purposeful business is becoming more and more accepted by investors and business leaders alike, especially those of the younger generation. It is important and relevant because a significant evolution in this direction could effectively complement state intervention and modulate its contours. This will require an overhaul of business organization, the incorporation of purpose into corporate law, and a reorientation of ownership and governance to support the purpose.

[12] Bozio *et al.* (2020) argue that policy discussions should focus more on pre-tax inequalities, i.e., the pre-distribution rather than just on the redistribution through taxation.

Effective policy design and implementation require trust in the state. Unfortunately, institutional trust deteriorated in many advanced economies because of rising unemployment, the shrinking middle class, and growing inequalities caused by the Great Recession, globalization, and technology (see for example Algan *et al.*, 2017). Restoring institutional trust seems therefore to be an important cornerstone of a rebuilding of the welfare state.

4.1. Steering technological change

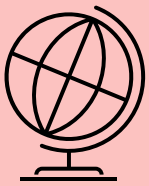
To tackle externalities in innovation that may lead to the under-provision of labor augmenting technologies, governments can retake part of the control over which
technologies are invented by subsidizing research and creating economic incentives.[13] Historically, many path breaking inventions were the outcome of public-private partnerships. In the US, the government financed technological innovations through its military research agency DARPA that led to innovations such as GPS or the internet. In recent years, governments also led the way in the ongoing transition towards a green economy via subsidies and carbon pricing that made it profitable for firms to develop and adopt low carbon emission technologies in the last years (Acemoglu, 2020b). In fact, investing public resources in societally beneficial sectors such as green energy or medical advances likely lead to the development of new services and products that increase the demand for human labor rather than replacing it. Most importantly, just as in the case of climate change, societies need to agree on the negative externalities created by too much automation, quantify it, and influence technological development through direct subsidies and incentives. For example, governments could sponsor research in labor augmenting technologies, such as virtual reality technologies that can increase the productivity of workers, for example in manufacturing or healthcare.

Besides providing funds, states can also change the playing field for private innovators. An important component is competition policy which should be rethought. Antitrust laws that limit the size of large technology companies such Google or Facebook and their power over future technology paradigms would strengthen competition. More competition would lower barriers to entry and encourage new firms with different ideas and visions to enter the market, altering the course of technological change (Korinek and Stiglitz, 2017; Acemoglu, 2020b). Thus, instead of only preparing workers for an inevitable future of ever-growing automation technologies, governments could play an important role in directing technological change towards innovations that complement existing and future human skills (Rodrik, 2020a).

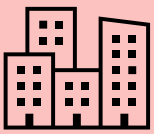
[13] One critique to governments intervening in the innovative process is that it is very difficult to know ex ante which innovations induce jobs and which destroy work. Often the same technology can have both effects, either directly or by paving the way for future subsequent innovations. For example, computers made office workers more productive from the 1970s onwards and created jobs in programming and online services, but they are also the foundation for automation technologies such as robotics and AI that will destroy some jobs.

Box-2: Multilateral versus local solutions

Most policy proposals responding to automation technologies require a stronger involvement of governments, but at which level? Should challenges posed by automation be addressed by national governments only, or is there a need for a multilateral approach, or on the contrary, should local communities be more strongly involved?



Take the ***example*** of autonomous vehicles that have the potential to replace millions of truck drivers. As reskilling truck drivers might be difficult, a country could decide on implementing regulations to slow down the adoption of self-driving automobiles to protect human drivers (a prohibition of unmanned autonomous vehicles would be easy to implement). If a country is sole in resisting adoption of driverless vehicles, it might lose out in comparison to other countries that benefit from the productivity increase of autonomous cars. This could lead to all countries abstaining from regulating the technology, even if regulation is welfare improving. Whether national control is beneficial might therefore crucially depend on the degree to which technology adoption affects international competitiveness. Abstaining from the adoption of driverless cars likely does not hurt countries as much as imposing strict regulation on industrial robots or as increasing taxation, both of which could spur the relocation of plants and capital.



A ***multilateral*** approach in which countries coordinate on policies can be more beneficial for all countries, particularly in the case of technological regulation (4.1), and the taxation of automation (4.2), capital and incomes (4.4).

Other policy approaches might require a more detailed ***local*** knowledge and build on local initiatives, such as the reskilling of workers, and the creation of good jobs in communities affected by automation technologies (4.3)

4.2. Taxing automation

Acemoglu, Manera, and Restrepo (2020) argue that tax codes are distorted and benefit the use of capital relative to labor. For example, in the US labor is taxed at a rate of about 25-33%, whereas capital taxation is only at about 5%. Acemoglu, Manera, and Restrepo (2020) document that an

optimal taxation would tax capital at a higher rate than labor, thereby increasing total employment. This fiscal distortion is pervasive and correcting it appears to be a natural precautionary measure vis-à-vis the risks to employment that we have highlighted. It is, however, a measure that requires a minimum of multilateral coordination as go-alone nations risk losing massively in the context of the international fiscal competition. A more specific proposal put forth by these authors is the idea of an automation tax, a tax that targets marginal tasks where automation does not bring much productivity gain. An important hurdle in implementing such a tax, however, is the identification of those marginal cases.

25-33% TAX RATE ON LABOR

5% TAX RATE ON CAPITAL IN USA

Going beyond taxing marginally productive technologies, the "robot tax", an idea brought into the public eye by Bill Gates, aims at taxing the use of all robots directly (Walker, 2019). A robot tax could slow down the speed of automation so that societies have additional time to adjust. It would also raise money for governments used as redistribution to workers that lose their job because of automation. The robot tax is however, a very controversial idea as slower robot adoption will likely curtail productivity, which could be an unnecessary high cost considering the ambiguous effects of robots on employment identified in the empirical literature (see Section 3.2). Moreover, the tax also bears the risk that companies relying heavily on robots move to countries without taxation, calling for increased international cooperation and a multilateral approach. Finally, like for the automation tax, implementation is difficult: when is a machine a robot?

4.3. Creation of "Good Jobs"

To counter the displacement of middle-class labor, policies that focus on the creation of "good jobs", i.e., jobs providing a wage sufficient for a comfortable (middle class) living and allowing civic and political participation, seem particularly valuable (Acemoglu, 2019; Rodrik, 2019a; Rodrik and Sabel, 2019). Unlike policies that purely redistribute after production has taken place, policies that promote "good jobs" provide incomes and enable citizens to work in a meaningful job from which they draw purpose and dignity.[14] Increasing minimum wages, strengthening collective bargaining, and including workers in the decision-making process of firms are important policy tools to improve the quality of jobs. Yet alone, in a world of increasing automation they could create incentives for firms to automatize even more in the face of increasing labor costs (Acemoglu, 2020a).

Thus, policy should tackle job-creation directly and on a broader scale. This could be envisaged through i) expanding the supply of productive firms that provide employment (e.g., through infrastructure investment, customized business services for small and middle-sized firms); ii) labor market policies to help workers building up the skills that are required in these jobs (see 4.5); iii) innovation policy (public-private partnerships) to

[14] Such policies would require that governments can identify "good jobs" in the first place. However, even well-intentioned governments might implement policies that do not correspond to the needs of workers.

direct technological change (see 4.1) (Rodrik, 2019a; Rodrik and Sabel, 2019; Rodrik, 2020b). An important aspect in job creation could be the departure from one-fits all policies towards the design of policies based on local needs and circumstances and under the guidance of local politicians and experts (Rodrik, 2020b).

4.4. Redistributive policies

There is a wide consensus that high-income societies need policies that guarantee a more equitable ways of sharing the benefits from technological progress and globalization (Acemoglu, 2020a; Bhatt *et al.*, 2020). A more equal income distribution would require restoring tax progressivity by increasing top marginal income tax that have been declining throughout the second half of the 20th century (Bhatt et al, 2020).[15] However, the rich and superrich increasingly derive a large share of their incomes from capital gains. Thus, taxing gains from capitals at higher rates is important, too (Scheuer, 2020). Besides income taxation, a wealth tax has been proposed to reduce inequalities (see for example Saez and Zucman, 2020). An IGM Chicago panel of expert European economists from 2020 indicated that a majority of economists are supportive of the idea that a wealth tax is a good instrument for reducing inequality.

A MAJORITY OF ACADEMIC ECONOMISTS SURVEYED SUPPORT A WEALTH TAX TO REDUCE INEQUALITIES.

Two redistribution schemes that have been suggested to ward off increases in inequality from automation are social wealth funds and universal basic incomes (UBI). Social wealth funds make societies participate in the gains from technological innovation by owning parts of firms and paying dividends to citizens (Smith, 2017; Korinek and Stiglitz, 2017). This might be an unavoidable development in the extreme scenario whereby general-purpose AI technologies would lead to the complete elimination of human labor. In such a scenario, which would generate massive human and social challenges, the collective ownership of the stock of capital and appropriation of the profits generated for distribution to the people, would be the first line of defense. An UBI, an idea that is heavily supported by parts of the tech industry (Sadowksi, 2016), is an unconditional cash transfer possibly financed by taxes on capital gains. While limited pilots, such as in Finland in 2017, show positive effects of UBI on wellbeing, critics argue that it is too expensive, not progressive, and does not consider special needs. UBI therefore bears the risk that rich tech firms pay off the masses losing from technological progress rather than empowering them (Acemoglu, 2019).

4.5. Education and reskilling

Technology will change the demand for skills for workers that enter the labor market and midcareer workers that need to transition to different or new occupations. Education and lifelong learning programs to facilitate job transitions will be of great importance. Besides the content of teaching that will need to change, teaching itself will see a need to be altered,

[15] In 1950, the top marginal income tax rate was in the UK at 97% (2013: 45%), in the US at 84% (2013: 39.6%), in Germany at 75% (2013: 45%) and in France at 60% (2013: 53%). Numbers taken from Our World in Data: https://ourworldindata.org/taxation#taxation-of-incomes.

assisted by technology, and more strongly targeted to adult and continuous learning.

The focus of education policy should be on teaching skills that are either complementary to novel technologies such as AI, and/or that will not be replaced by automation in the short term (Agrawal *et al.*, 2019b). These are obviously STEM skills that allow people to handle novel technologies, for example to program a machine learning algorithm. In addition, "human" skills, such as creativity and social skills, will be important that prepare people for jobs with human-to-human interactions such as managerial jobs, social work, and care (Pissarides, 2019).

EDUCATION POLICY SHOULD FOCUS ON SKILLS THAT ARE COMPLEMENTARY TO NOVEL TECHNOLOGIES SUCH AS AI, AND/OR THAT WILL NOT BE REPLACED BY AUTOMATION IN THE SHORT TERM.

The adaptation of workers to changing tasks requires retraining and lifelong learning. Governments need to step in to fund learning programs. In the US, for example, the Trade Adjustment Assistance (TAA) that was targeted at workers losing their jobs because of globalization could be improved and extended to workers affected by automation. Unfortunately, the scope and effectiveness of the original TAA program was disappointing (Bhatt *et al.*, 2020). Particularly effective in retraining workers to gain new skills are programs that take place in companies or build a strong employer relationship, such as work-based learning programs and sectoral employment programs for disadvantaged workers (Author *et al.*, 2019). Dual education systems that combine apprenticeship-based training with vocational education, such as traditionally practiced in Germany and Switzerland, seem promising as there is a strong link between training and the skills needed on the job (Meyers and Besanko, 2017). It is a win-win for firms that get well-trained workers, and employees that receive skill training.

To identify effective reemployment and retraining policies, additional research is needed that investigates the precise skills demanded by occupations and those possessed by workers and localities. Better skill data with high temporal and spatial resolution, a more detailed understanding of how changes in micro-level workplace skills lead to aggregate labor market effects, as well a more precise identification of the regional distribution of skills and the dependencies across localities will be valuable for overcoming these hurdles (Frank *et al.*, 2019).

5. Conclusions

Automation technologies will significantly change our economies but will likely not - at least in the foreseeable future - make human labor obsolete. Yet, the transformation and displacement of traditional tasks and occupations have the potential to generate significant disruptions of labor markets with implications for human wellbeing, and the distribution of incomes. In fact, this process has already started and needs to be addressed with innovative approaches and novel collaborations between economists, politicians, and business leaders.

Economists have made a number of proposals to address the impact of automation. With the help

of big data, they are currently also in the process of better understanding and forecasting which tasks and jobs are being replaced by machines, and how the skills of workers can be reused so that humans can keep occupations that provide them with incomes, as well as purpose and dignity. Unlike the laissez-faire approaches of previous decades, many economists today advocate greater interventions by governments. Not only is there a need for a more equal sharing of the gains of economic growth, but there is a demand for policies that promote more equal labor market outcomes, i.e., that focus on the pre-production and production phases. Steering technology towards labor-augmenting innovations and correcting the imbalance in the taxation of capital and labor are key policy measures that would set the right conditions and incentives for firms to create jobs rather than to replace humans with machines. Smart education policies that prepare workers for new tasks and facilitate their adaptation to a changing workplace are equally important to guaranteeing a bright future for work.

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