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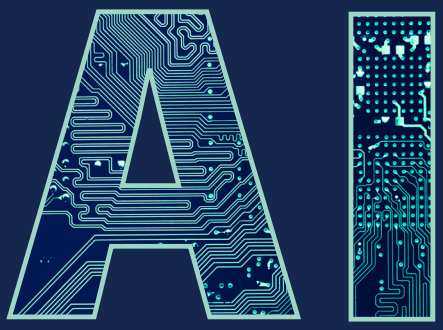

THE FUTURE OF WORK? WORK OF THE FUTURE!

On how artificial intelligence, robotics and automation are transforming jobs and the economy in Europe

DG Connect
https://www.gmfus.org/profiles/michel-servoz

A report by Michel Servoz

'Don't panic'

These words are written in large letters on the cover to the hitchhiker's guide to the galaxy (Douglas Adams, 1979)

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INTRODUCTION

Sources: Business Insider, US National Archives, George Grantham Bain Collection.

We are used to thinking about artificial intelligence (AI) in the future tense, speculating how technological developments in this area will affect us. While we use (too much of) our energy trying to figure out what to expect in the future, we sometimes miss the point that AI and robotisation have already started transforming our daily lives.

The markets for robotics and AI are growing fast. Recent forecasts suggest that global spending on robots will be USD 188 billion in 2020, up from less than half that amount in 2016. By 2025, the worldwide AI market is forecasted to grow to USD 59 billion, a significant increase from the USD 1.8 billion spent in 2016. While the extensive uptake of AI and robotics is likely to generate higher productivity growth, which is urgently needed in ageing societies, it will also bring certain challenges.

What do recent technological developments in AI and robotisation foreshadow for the future of work? Should you be worried or excited? Which jobs will be destroyed and which new ones created? Who will help you if you lose your job due to automation? What is the role that education systems, businesses, governments and social partners have to play in managing the upcoming societal transitions? These are some of the questions this report will try to answer.

Consider these examples, which illustrate the extent to which AI is already changing our lives.

In your smartphone, an effective personal assistant is hidden (Siri). She is the amicable voice-activated assistant that we interact with daily. She adds events to our calendars, helps us find information, sends messages on our behalf and gives us directions. Siri is a digital personal assistant. She uses machine learning technology to better predict and understand our natural language requests and questions. Do you still need a secretary?

Transactional AI has existed for quite some time, enabling the development of e-commerce (e.g. Amazon). With algorithms that improve with each passing year, companies are getting increasingly smart at predicting exactly what we are interested in buying based on our online behaviour. Do we still need to go shopping? Do we still need sales assistants?

You probably have not yet seen someone reading the newspaper while driving to work, but self-driving cars are moving closer and closer to reality. They are currently being tested in real-life conditions in different parts of the world: Google's self-driving car project and Tesla's 'autopilot' feature are two examples that have been in the news lately. Google is developing an algorithm that could potentially let self-driving cars learn to drive in the same way that humans do: through experience. Do we still need taxi drivers?

A security guard monitoring video cameras is not a secure system: people get bored, and keeping track of multiple monitors can be difficult. Which is why training computers to monitor cameras makes a great deal of sense. Security algorithms can take data from security cameras and learn whether there may be a threat. They can use facial recognition to identify a suspect and the enforcement authorities can use it to trace the suspect through the many cameras installed in public places. Do we still need security guards?

On many websites you will come across a pop-up offering personalised assistance. In many cases, this is AI and not a human interacting with you. Customer support has now turned into an important task for AI. It collects the user's query, cross-references it with the solutions to see if it fits any of them and if so provides support. Complex queries are forwarded to customer care agents. A company specialising in emotional artificial intelligence has developed AI software to perform in-call analysis and perceive the emotions of clients through their speaking patterns, verbal cues and other social signals. The algorithm gives call centre agents real-time insights into the emotional state of the customer. It may recommend talking slower or less frequently, or indicates that the caller is annoyed, guiding the agent through the conversations and helping them be sympathetic and efficient. Do we still need call centres?

The use of artificial intelligence in the legal profession is an emerging area that is beginning to influence the practice of law and affect employment trends in the field. So far, most AI software for legal applications is intended for use during the discovery phase of the trial process, enabling tasks such as the review of large numbers of documents to be conducted by fewer attorneys rather than by the large teams of lawyers and paralegals traditionally required. Such 'e-discovery' software uses advances in areas such as natural language processing, knowledge representation, data mining, pattern detection and social network analysis. Do we still need lawyers?

The above examples are all reality today. Their effect is already felt in the work organisation of firms and the nature of services provided to customers. Obviously, the questions above are all meant to be provocative. In most cases, we still need assistants,

drivers, lawyers, security guards, sales assistants, call centre operators, but their number may be reduced and the content of their tasks will become more sophisticated, requiring a higher skills level.

While we will most certainly need a crystal ball to foresee exactly how jobs will evolve in the future, a central point that will be made in this report is that **automation outcomes are not pre-determined, and will be shaped by the policies and choices we make**. Instead of worrying about what could happen due to automation and increased uptake of AI, we should focus on what **should** happen. This report explores the policy choices that AI and robotisation present for the future of labour and puts forward recommendations on addressing these choices. In doing so, the report focuses on the problems arising from automation and their solutions and not so much on subsidiarity, national and EU competences. The policy recommendations are meant to galvanize the debate around the labour market impact of AI and sketch possible solutions. A thorough discussion on which level of governance does what would need to follow this debate. The policy choices and considerations explored in the report are thus relevant for policymakers at all levels of government.

The rest of this report is structured as follows: the executive summary and summary of recommendations follow this introduction.

Chapter 1 provides an overview of previous labour market transformations.

Chapter 2 examines how automation is changing the economy.

Chapter 3 analyses in depth the impact of AI and robotics on labour markets.

Chapter 4 looks at the implications for education systems and new forms of work.

Chapter 5 delves into the preconditions for developing viable AI ecosystems in Europe.

Chapter 6 looks at how the organisation of work can be renewed and societal implications addressed.

Chapter 7 puts forward the policy recommendations stemming from the analysis in this report.

Chapter 8 concludes.

Annex I summarises the AI strategies of several EU Member States and of the USA, Canada and China. Annex II is a synopsis of the exchange of views with European social partners on the subject of the report.

EXECUTIVE SUMMARY

THE REPORT IN NUMBERS

90%

OF JOBS NOW
REQUIRE IT SKILLS

61 million people

IN THE EU WITH
INSUFFICIENT BASIC SKILLS

DIGITALISATION CREATED
2 MILLION
NEW JOBS
IN THE EU IN THE LAST DECADE

1.75 million new jobs

ARE EXPECTED
IN ICT BY 2030

14% TO 47%

ESTIMATES OF JOBS AT
RISK OF AUTOMATION
VARY WIDELY

AI IS GETTING BETTER
2.5%
ERROR RATE
IN IMAGE LABELLING, TWO
TIMES LOWER THE HUMAN LEVEL

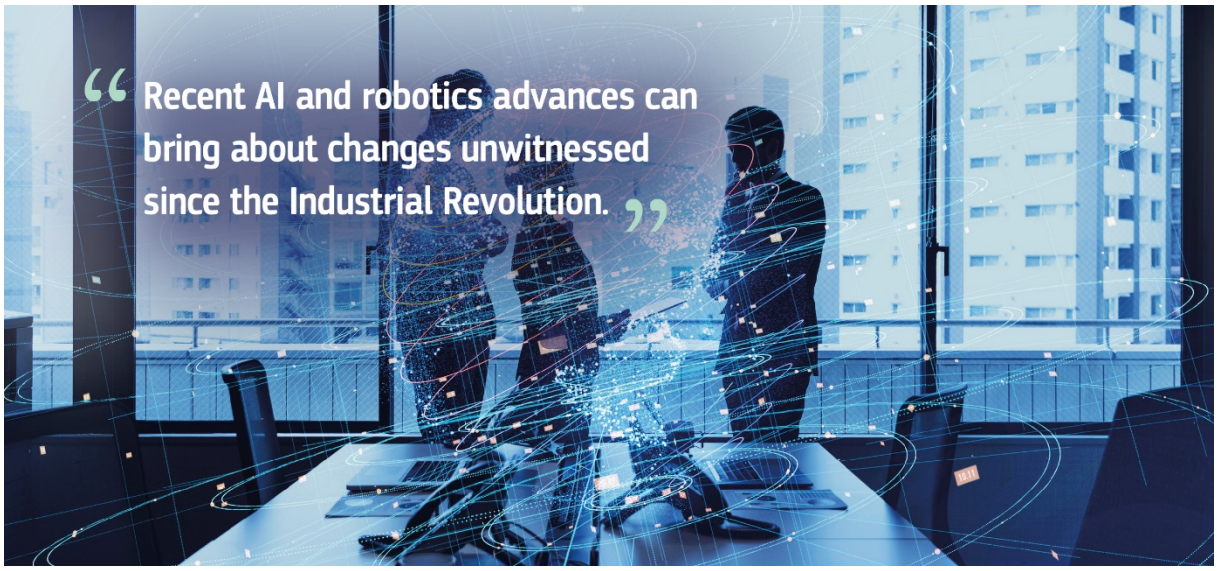
CROSS-BORDER
DATA HAS GROWN
45 TIMES
SINCE 2005

20%

PROPORTION OF EU COMPANIES,
WHICH ARE HIGHLY DIGITISED

85%

OF MACHINE
LEARNING
WORKFORCE IS MALE



Automation outcomes are not pre-determined but are shaped by the policies and choices we make. Instead of worrying about what could happen due to automation and increased uptake of AI, we should focus on what should happen. This report explores the policy choices that AI and robotisation present for the future of labour and puts forward recommendations on addressing these choices.

The new digital technologies will have different impacts on jobs in the short and longer term. To grasp the full story, we need to consider the time dimension of the issue. While automation may displace workers within a sector in the short term, historical evidence suggests that overall employment also grows when looking at a longer period and across the entire economy, not just at the sectors most likely to face disruption.

In the longer term, fears of massive displacement of workers are unfounded. This is because new jobs will be created, some of them in sectors we cannot conceive of yet. More importantly, from a public policy perspective wide-scale automation has the potential to significantly disrupt labour markets in the short term unless policymakers take proactive measures to manage the risks. Recent artificial intelligence and robotics advances have the potential to bring about changes unwitnessed since the industrial revolution.

AI and robotics will cause some jobs to disappear and new ones to appear, but will also improve the quality of jobs. The evidence suggests that the digital revolution not only created much more jobs than it destroyed, but also improved the quality of jobs and services. New digital technologies have so far augmented workers and allowed them to focus on more important and personally gratifying tasks.

It is yet unclear if the net effect stemming from AI and advanced robotics will be the replacement or augmentation of work. This will also depend on the time dimension mentioned above. While the historical evidence of previous automation waves has been overwhelmingly positive, AI as a distinct category has the potential to be much more disruptive. It builds upon other digital technologies but is distinctive in its stronger potential to bring about and amplify socioeconomic changes. This makes it very hard to predict the result of the interplay between job displacement and job augmentation. How extensive the impact on labour markets will be would also depend on how far and how fast AI technology develops and is adopted.

To make the AI revolution successful for our economies, we will need to address societal transformations. The single most important factor in achieving this will be managing short-term labour market transitions. Unlike earlier transitions, when young people left farms and moved to cities for industrial jobs, the challenge brought about by automation will be to retrain mid-career workers. Worker transitions, adaptation and skills requirements will be significant challenges to face when adapting to the coming age of AI. Complex transitions will be unavoidable, as the places and sectors where new jobs will be created are not the same as the old ones being lost. The net effect of automation on job creation will also be influenced by the pace at which displaced workers could be retrained and migrate towards newly created jobs. To manage the transitions brought about by automation and AI, therefore, the role of education systems will be paramount.

Artificial intelligence should be open, accessible and understandable to everyone in society. There is a growing anxiety across different parts of societies in European countries regarding the negative impact of the digital transformation. The development of understandable AI systems is a fundamental necessity if AI is to become an integral and trusted tool in our society. Beyond the debate on the future of work, there is a growing anxiety about the social implications of artificial intelligence regarding possible intrusions in privacy and risks of discrimination and exclusion.

Advanced automation technologies can bring about many opportunities but also risks. These risks and opportunities are not equally distributed across society or the economy. Gender, ethnic and socioeconomic diversity are important because careers in AI are well remunerated and are an area of rapid growth. Continued dominance of these positions by already privileged groups in society is thus likely to exacerbate existing inequalities.

Unless mitigating action is taken, the growing uptake of AI can increase existing inequalities within societies and further reinforce the divide between rich and poor. Many of the jobs that will be replaced by AI include routine and repetitive tasks, which in most cases overwhelmingly employ lower-skilled workers. The increased uptake of

AI and robotisation could thus exacerbate the divide between highly skilled and low-skilled workers. This divide is on the increase and is compounding inequalities in the workforce.

The global slowdown in productivity growth is at least partially caused by increasing productivity divergence between firms. Companies at the global frontier continue to enjoy robust productivity growth, moving further ahead of laggard firms. Only about 20 % of firms are early adopters of technologies such as AI. Small and medium-sized companies often struggle to access large datasets of good quality, which puts them at a competitive disadvantage compared with big (mostly US-owned) technology companies. In an overall shortage of AI developers, SMEs find it especially difficult to attract the talent needed to help them transition to AI. In addition, SMEs very often have access neither to the necessary funding nor to advice on how to utilise AI in their business models.

To benefit fully from the economic opportunities AI could offer, Europe needs to foster the development of AI ecosystems on the continent. **The speed of change is a crucial factor in this regard.** There are currently nine companies[1] driving worldwide AI development and none of them are European. Europe's competitive edge in artificial intelligence depends on the quality of our research and the excellence of our universities in disseminating knowledge and preparing students for jobs involving the use or development of AI systems. Although there are excellent universities in Europe, there is no research centre dedicated to AI with sufficient scale and international visibility to attract the best researchers in the world and to mobilise the support of large corporations. Furthermore, while Europe has invested USD 3 to 4 billion in 2016, Asia has invested three times and North America five times this amount in the same period.

20 recommendations for a successful digital transition

To address the points raised above, this report puts forward the following 20 recommendations.

Youth education

We do not know what the jobs of the future will be, but we do know they will be dominated by computer science. We also know that our children will have several career transitions. This means that what will be important for them is not so much technical knowledge but the capacity to acquire it. They will need to learn how to learn.

- Computer science should be introduced as a new subject in the secondary education curriculum and given weekly teaching hours equivalent to those for

1 Google, Amazon, Apple, Facebook, Microsoft, IBM, Baidu, Tencent and Alibaba.

physics and biology;
- Teaching methods should be reviewed to give more space to soft skills and critical thinking, with the emphasis shifting to skill and competency acquisition rather than disciplinary topics and rote learning;
- The delineation between general education and technical education (VET) should be blurred to allow students to increasingly combine elements of both tracks in their individual pathways;
- Employers and public employment services should list the skills required for jobs instead of degrees/diplomas for vacancies they publish to encourage applications from a diverse skillset.

Adult education

Adult education today is not provided in a way that can help manage transitions; paradoxically, the higher skills you have, the more you will benefit from it. Instead of anticipating major reskilling needs, adult education is overwhelmingly focused on short technical training sessions, often designed for people who are out of work.

- Universities should reform their *modus operandi* to shorten the initial training period and allow students to come back to regularly complete and update their skills building on their on-the-job experience mid-way through their studies. This 'post-sale' service should be adapted to the constraints of adults in the form of reskilling services, coaching, online classes or sessions;
- A system for mid-career education should be created to help adults who need substantial training, for instance on their basic skills and general education, but also to prepare for a career change;
- Public employment services should be reinvented to provide employability insurance helping people to anticipate and prepare career transitions before any unemployment spells occur;
- The certification of skills learned on the job should be introduced. This would be offered by consortiums of companies and should be made equivalent to formal credentials provided by the education system.

Our digital potential

There is an ongoing race between a few countries to lead on artificial intelligence and robotics. The race is about getting the top-class computer infrastructure needed, recruiting the best AI researchers and helping the development of superstar firms in the field of AI. Europe is at risk of lagging behind on all these. To address this:

- Several AI hubs should be created, hosting researchers, academics (and their students) and investors, as it is proven that excellence in innovation stems from a cross-sectoral approach;
- Universities should review their curricula to quickly offer more computer science programmes focusing on AI and robotics to answer labour market needs;

- A specific mobility programme should be created to encourage the best international AI experts to come and work in Europe; such a programme should include the quick resolution of immigration formalities;
- Several super laboratories funded by public resources should be created. This would offer the necessary computing capacity for SMEs and researchers to develop AI algorithms and process datasets.

Work organisation

The distinction between workers and service providers is becoming increasingly blurred. As there is a constant need for individuals to anticipate and prepare transitions, social protection and collective representation need to be shifted from the labour contract to the individual.

- A universal personal account should be created to provide insurance against the main risks covered by social protection and to help prepare career transitions;
- The account should be portable in the same way as credit accumulated on a bank account to be used by individuals according to their needs;
- The universal personal account should be financed by a generalised social contribution levied on all services provided through platforms, while traditional 'social contributions' continue to be collected;
- Guilds covering 'sectors' of the new economy should be created to ensure collective representation of non-standard workers, leading (where appropriate) to agreements on fees and working conditions.

Social support

In public debates, a large cross-section of the European population, in their capacity as workers, consumers or citizens, express concerns about alleged risks resulting from the uptake of AI and robotics. Citizens need to be reassured that these technologies will be used to their benefits in full respect of our social values.

- A Board should be created at EU level to monitor risks of discrimination, bias and exclusion in the use of AI systems by any organisation. Where these risks do occur, the Board should propose measures of redress.
- Mechanisms should be provided by stakeholders (local authorities or companies) to ensure that decisions made through the use of artificial intelligence are properly explained and transparent.
- Principles, guidelines or a charter should be prepared as a solemn commitment to EU citizens that new technologies such as AI will be used in conformity with our social values.
- As all products and services resulting from AI are global by nature, international discussions should be launched to reach a common understanding on AI or to create a coalition of countries that will achieve this.

CHAPTER 1

SETTING THE STAGE

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The chapter at a glance

Have you ever considered what the connection is between finding a better way to plant seeds in early 18th century Britain and the development of self-driving cars today? If you have, you will most likely be aware that present day fears of AI destroying jobs are simply the continuation of a centuries' long struggle between longer-term technological progress and shorter-term societal changes.

Previous waves of automation have already transformed our economies and societies. In the last couple of centuries, workers have progressively moved from agriculture to manufacturing and then to the services sector. The impact on jobs differed in the short and longer term, but automation inevitably led to more and better jobs. Comparisons between previous waves of automation and the current AI 'revolution' are useful but need to take into account the specific characteristics of AI – it builds upon other new technologies but is distinctive in its stronger potential to bring about or amplify socioeconomic changes.

This chapter places the debate on the impact of AI and robotics on European labour markets in the context of recent shifts in the global economic landscape and examines the three forces at play: globalisation, digitalisation and economic atomisation. It also looks at the interplay between demographic developments and AI uptake in Europe.

The historical overview of the effects of previous waves of automation on labour markets raises two important considerations: first, in the longer term, fears of massive displacement of workers are unfounded, as new jobs will be created, some of them in sectors we cannot conceive of yet. More importantly, from a public policy perspective wide-scale automation has the potential to disrupt significantly labour markets in the short term unless policymakers take proactive measures to manage the risks.

1.1. Lessons from history: how have labour markets reacted to previous economic transformations?

1.1.1. Explaining historical trends

The current wave of automation is by no means the first. It is linked to several phases of the economic transformations of countries moving from subsistence agriculture to manufacturing and then services. Looking back at these previous automation waves is useful when drawing lessons to be applied to current technological developments.

In Europe, a first wave of automation took place in agriculture in the 18th and 19th centuries. This subsequently enabled farmers to migrate to factories, decreasing the share of agriculture in employment from over 54 % in 1840[2] to 17.5 % in 1960[3], while increasing the share of manufacturing. Another wave of automation in the 1960s and 1970s, this time in industry, freed workers to move to the services sector. In the US, the share of agriculture in total employment went down from 60 % in 1850 to less than 5 % in 1970[4], while in countries like China the decline was even faster, with 33 % of the workforce moving out of agriculture in just 25 years, between 1990 and 2015.

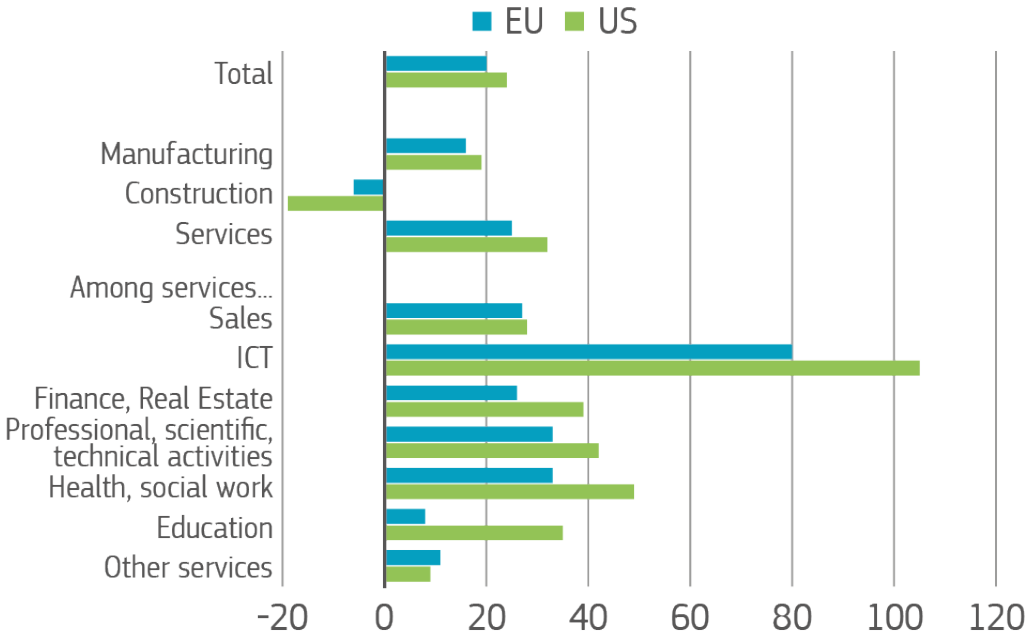
Looking at the impact of previous waves of automation on jobs, an important distinction needs to be made between short and longer-term effects on employment. In the United States, the share of manufacturing in total employment decreased from 26 % in 1960 to less than 10 % in 2017, while in Germany it dropped from around 40 % in 1970 to less than 20 % in 2017 (see Graph 1). In both these countries, increased automation led to a boost in productivity and reduced the need for workers in a given sector. This decreased the

2 Nick Crafts (1987). The Industrial Revolution: Economic Growth in Britain, 1700-1860
3 Henrik Zobbe (2001). The Economic and Historical Foundation of the Common Agricultural Policy in Europe. Statistics for the EEC 6.
4 https://datacatalog.worldbank.org/dataset/world-development-indicators

relative costs of manufactured goods and increased the overall standard of living. Automation also allowed resources to migrate to other sectors and increase the production of other goods. This has important implications for the current wave of automation and increased application of AI technologies, and shows that in the medium term, alarmist sentiments about a massive disappearance of jobs are misplaced. While automation may displace workers within a sector in the short term, historical evidence suggests that overall employment also grows when looking at a longer period and across the entire economy. However, an important policy implication is how to manage the transitions necessitated by job displacements in the short term.

Graph 1: More services, less manufacturing

Real value added, percentage change between 2000 and 2015, EU-28 and US



Source: ESDE 2018

Historically, the evidence shows that even when machines directly replaced jobs, this still led to job creation. Religious scribes were replaced after the invention of the printing press, which in turn created a huge number of jobs. Similarly, all horse-related jobs were replaced when cars were invented and went into mass production. However, jobs were also created, not only in the automobile industry, but also in the building and maintaining of roads. Telephone operators, who were numerous at the time of landline telephony, disappeared at the end of 20th century with the arrival of new technology.

Another important historical lesson is that automation technology not only disrupts jobs but can also 'augment' them. One specific example that comes to mind is that originally 'computer' was a profession, now replaced by computers as machines. As computers

became cheaper after their introduction, they began competing directly with human 'computers' in the performance of jobs heavy in routine tasks. Employers increasingly chose computer-performed routine tasks instead of human-performed routine tasks. However, as they also complemented each other, the increased supply of computer-based routine tasks increased the demand for non-routine tasks, which drove the wages and employment associated with these tasks higher.

The historical overview of the effects of previous waves of automation on labour markets raises two important considerations: first, in the longer term, fears of massive displacement of workers are unfounded, as new jobs will be created, some of them in sectors we cannot conceive of yet. More importantly, from a public policy perspective wide-scale automation has the potential to disrupt significantly labour markets in the short term, unless policymakers take proactive measures to manage the risks. Recent artificial intelligence and robotics advances have the potential to bring about changes unwitnessed since the industrial revolution. To mitigate the potential risks, it is of primary importance that European governments manage the transitions brought about by AI and robotisation.

1.1.2. Recent transformations (going digital)

The digital revolution, which started in the 1960s, offers the best approximation of how we can expect AI and robotisation to impact labour markets. Mobile internet connectivity, laptops and smartphones are the foundation upon which the age of AI is built. Their impact on jobs is a useful proxy for the impact of AI. If we are to judge what the future of work holds based on this proxy, we have no cause for concern.

McKinsey (2017b) estimates that the introduction of the personal computer has enabled the creation of 15.8 million net new jobs in the United States since 1980, including the jobs displaced. About 90 % of these are in occupations that use the PC in other industries, like call centres, financial analysis and inventory management. 30 % of the jobs created in the past 25 years in the US were types that did not exist before, in particular in IT development, app creation, IT systems management and security. The internet has destroyed 500 000 jobs in France in the past 15 years but at the same time has created 1.2 million others[5]. And the automobile industry in Germany, which has been the most advanced European economy in terms of robotisation for a long time, is seeing a constant increase of its workforce, which stood at 800 000 in 2016, 100 000 more than 20 years ago.

The evidence suggests that the digital revolution not only created many more jobs than it destroyed but also improved the quality of jobs and services. Artificial intelligence now offers strong potential to accelerate and deepen such improvements in many sectors. For instance, preventable medical errors are the third largest cause of death after cancer and heart diseases in the US: artificial intelligence can be a major help in reducing this cause of

5 https://gulfnews.com/opinion/op-eds/future-jobs-and-the-importance-of-developing-the-local-workforce-1.2214821. Last accessed on 20 March 2019.

death! New technologies have augmented workers and allowed them to focus on more important and personally gratifying tasks (such as advising customers rather than simply handing out banknotes in the case of bank tellers). In this sense, and especially if focusing on the impact on the entire economy as opposed to particular job sectors, the coming age of AI and robotisation is not a cause for concern, but rather an opportunity to be embraced.

1.1.3. Is it different this time?

The previous section draws a comparison between the effects of digitalisation on labour markets and the foreseen impacts of AI. Indeed, the historical overview presented so far seems to equate the present wave of automation with previous ones. Certainly, some of the changes the current wave of automation is expected to bring will resemble developments witnessed before. Other changes, however, could be much more disruptive. Automation and robotisation threaten mostly low- and medium-skilled jobs. However, AI as a distinct category has the potential to disrupt and displace some high-skilled jobs as well. AI builds upon other new technologies but is distinctive in its stronger potential to bring about or amplify socioeconomic changes. AI is not only influenced by new technologies, but as it develops, it also influences them. For example, DeepMind (a subsidiary of Alphabet Inc., the parent company of Google) used AI to reduce the energy needed to cool Google's data centres by up to 40 %. In this sense, it can speed up the impacts of other new technologies on labour markets and social systems.

AI is just one of the transformations linked to digitalisation; in fact, it is just one step in a continuous process of automation. However, the recent acceleration of the automation process, and the potential presented by AI poses a question: is it different this time? Should we expect business as usual, or is AI something truly 'game changing' when it comes to the world of work? The short answer is both. Indeed, it is difficult to make sound predictions on how artificial intelligence and robotisation will affect the organisation of work. Two scenarios seem possible.

The first scenario, which appears to be the most plausible in the short term, is that of a progressive transition. This corresponds to an evolution where workers will benefit from the automation of a substantial number of routine tasks performed by humans until now. This concerns, for instance, detection of anomalies, speech recognition, visual recognition, digitalisation of financial services transactions and physical assistance to patients. In all these cases, AI and robotisation improve substantially the productivity of workers, based on complementarity between humans and machine.

However, a second credible scenario for the medium term is that of a substantial disruption. Indeed, the current wave of artificial intelligence is based on machine learning, where data accumulation allows for increasingly sophisticated predictions leading to sound proposed decisions. The resulting improvement of algorithms is continuous and may lead to a complete reorganisation of some workplaces. For instance, some experiments show that

in judicial systems, machine-based decisions could eventually be fairer and more consistent than those of humans. This also applies to human resources' recruitment processes, or to loan decisions in banks.

In the first scenario above, based on complementarity, humans remain in charge of a decision proposed by machines. They assume responsibility, can overrule the machine and have to explain their decision. Nevertheless, what happens if machine decisions are demonstrated to be more accurate and fair? We will then be moving to substitution rather than complementarity. In such cases, there is a risk of disqualification of workers and loss of autonomy, leading to fragmentation of tasks and devaluation of some jobs. This may be the case in situations where automatic systems transmit instructions to workers who simply execute them. If in the healthcare sector, the diagnoses produced by the machine are systematically more accurate than those of humans, the radiologist profession will be gradually disqualified, but the nurses who manage all the human interactions with the patients will be increasingly important, and may eventually attract a better salary than the radiologists.

The first scenario is the least disruptive for the economy and for workers, and the one on which policies should focus at present, given it is much more likely to occur (at least in the short term). It implies a strong capacity to anticipate the tasks that can be substituted, and those where humans and machines complement each other. This will also necessitate taking into account not only economic considerations, but also:

- social acceptance: are we all ready to accept that our cars will be driven by machines?
- available skills: are there enough workers with the soft skills necessary to perform the tasks that machine cannot do, such as coaching, caring and connecting?
- regulations: do we accept machine-based recruitment processes instead of interviews with the managers of the firm?

How extensive the impact on labour markets will be also depends on how far and how fast the AI technology develops and is adopted. As McKinsey (2017c) points out, five major factors are likely to affect the pace and extent of adoption. First is technical feasibility - the technology has to be invented, integrated and adapted into applicable business solutions. Second is the cost of developing and deploying these solutions, as they influence the business case for adoption. Labour market dynamics are the third factor, including the supply, demand and costs of human labour as an alternative to automation. Next come economic benefits, such as higher throughput and increased quality, as well as labour cost savings. Last but not least, regulatory and social acceptance can affect the rate of adoption even if deployment makes business sense.

Irrespective of whether we fall into the 'business as usual' or 'game-changing scenario', we need to make sure we are ready to manage the short-term transitions the inevitable job transformations will necessitate. Before exploring these transitions in more detail, however, it is useful to first look at the changing economic landscape.

1.2. Shifts in the economic landscape

1.2.1. Changes linked to automated technologies: globalisation, digitalisation and economic atomisation

To begin to understand the changes AI and robotisation will bring to European labour markets, we need to put them in the context of recent shifts in the global economic landscape. In recent years, the preoccupation has been fighting unemployment in the aftermath of a deep economic crisis. However, in parallel the economy has undergone a massive change. What are the key drivers of this change? **Three forces are at play in this seismic shift: globalisation, digitalisation and economic atomisation**. They are linked and in fact each has an impact on the organisation of work.

Globalisation is a major driving force behind the economy today, but it is also evolving. A decade ago, globalisation meant tangible flows of products, led by multinationals from developed economies, in global supply chains. Large companies were moving their production out of Europe and into cheap labour countries. The concern was about manufacturing jobs leaving Europe.

Now, globalisation mostly refers to intangible flows of services in – not just supply – but global value chains. This is happening in developed and emerging economies. Moreover, it is not only a feature of the organisation of big multinationals: many small companies are engaged in globalised activities (with over 80 % of European exporters being SMEs). While the debate 10 years ago was about globalisation leading to job losses in Europe, we now see 'relocation', and new jobs being created in the service sector because of globalisation.

As was already pointed out in the sections above, **digitalisation** is another key driver of economic change. Automation of tasks implies their reallocation between workers and machines. Workers now focus on more complex tasks, with basic tasks performed by machines. This process is an ongoing one, which is constantly influencing industries and services, leading to productivity enhancements, better services for customers, and job changes or adaptations.

In recent years, we have witnessed the transformation of travel agencies and retail banking, which are increasingly replaced by online services: in both cases, employees now focus on providing individual advice to customers while the routine tasks are all automated. Banks have already seen a major transformation on the trading floors, where the profession of traders has been substantially replaced by algorithms, and now similar

changes are affecting retail banking. For instance, Sberbank relies on artificial intelligence to make loan decisions in 30 % of cases; this is expected to increase to 70 % in the next several years. Many of today's jobs may disappear in a few decades' time, but many new jobs will appear or will be transformed. Digitalisation also means that 90 % of jobs now require IT skills - even traditional ones. As the world of work of secretaries, waiters and drivers has become digitalised, so their skills must keep up. The skills dimension is further explored in Chapter 4.

Digitalisation implies that people can choose to work where labour and living costs are lower. Therefore, while some jobs may be destroyed, others can be created in less developed regions. This may mean reduction of labour costs by locating online services where labour is cheap. However, at the same time, this is a key factor of economic development and improving economic cohesion. It may also be a way to increase participation in the labour markets by vulnerable parts of the population (for example people with disabilities) or by women. In the future, successful participation in the globalised economy may depend less on where people live and more on the speed and quality of their internet connection.

The third key driver of economic change is **economic atomisation**. In the last century, large industrial conglomerates drove the economy. The second industrial revolution saw the wide dissemination of electric machines and appliances, cars, trucks and commercial air transport, radio, TV and motion pictures, plastics and antibiotics: all these products implied large centralised industries, operating top-down through vertical integration. With the third industrial revolution, the rapid evolution towards personal computers, the web, e-commerce, smart phones, barcode scanning gradually leads to a different, bottom-up driven organisation based on decentralisation and on horizontal networks collaborating with each other. With globalisation and digitalisation, the market presence of small companies therefore seems much stronger and the allocation of tasks between them is more fluid, leading to an increasing number of small and medium-sized companies and a myriad of micro online operators. While the economy is increasingly driven by decentralised, open networks of small players working independently on individual projects, this does not necessarily hold true for digital markets. These markets are increasingly highly concentrated and dominated by few market players, which control the economic landscape and make it increasingly uncompetitive.

These three factors (globalisation, digitalisation and economic atomisation) have indeed hugely affected the world of work, but with what consequences? The changing patterns of work are further explored in chapters 4 and 6.

The three change factors are also interconnected. Digitalisation is transforming globalisation. McKinsey (2017a) points out that since 2005, the amount of cross-border data has grown 45 times. By the early 2020s, it is expected to grow nine times larger.

These data flows enable the movement of goods, services, finance and people, with virtually every cross-border transaction now having a digital element. Around 15 % of global goods trade is done via international e-commerce (by platforms such as Alibaba, Amazon and eBay), while 50 % of the world's traded services are already digitised.

Digitalisation also diminishes the time and cost for companies to scale up. As the World Bank underlines in its 2019 World Development Report, it took IKEA 30 years after its founding to start expanding outside Sweden. After more than 70 years, it achieved global annual sales revenues of USD 42 billion. The digital platform Alibaba, on the other hand, reached 1 million users in 2 years and annual sales of USD 700 billion in 15 years.

The three key factors of economic change explored in this section are very relevant for the coming age of AI. Digitalisation is the foundation upon which recent advances in AI and robotisation stand. It has created the enabling technologies and economic environment for AI to come out of its latest 'winter'. Globalisation is the exogenous imperative why Europe cannot stand aside and miss the potential opportunities brought about by AI. Economic atomisation and its benefits for the development of the SME sector is what makes it important that policymakers address the threat of data monopolies (see Section 5.2) and make sure that artificial intelligence is open, accessible and understandable to everyone in society.

1.2.2. Changes linked to general economic trends: demographic developments and labour markets in Europe and the developing world

Looking at expected demographic developments in Europe in the next several decades, AI offers an important opportunity to mitigate their impact on labour markets and the economy. Less people in the labour force resulting from demographic developments in Europe may prove to be a drag on economic growth in the coming decades and the increased uptake of AI can alleviate this risk. What is more important is that the effect is indeed two-sided, as demographic developments can also alleviate the job displacement effect of AI. In this sense, population ageing in Europe has the potential to mitigate decreased labour demand resulting from artificial intelligence and automation.

The impact of AI on labour markets outside the EU also has important policy implications for our continent. Growing populations in developing countries such as India and Brazil could influence European labour markets in different ways, depending on the impact of AI and automation in these countries. For example, if the adoption of new technologies in the developing countries augments rather than replaces labour, the increased material wealth will boost consumption demand, which could be beneficial to European exporters. If, on the other hand, the displacement effect of AI and automation is more prevalent, this raises important migration considerations for Europe. In this scenario, many people in developing countries lose their jobs due to technologically induced unemployment and are unable to find a new job quickly, which is combined with further pressures on the labour markets

coming from growing populations. The evidence so far suggests that new technologies such as AI are adopted more slowly in developing countries, which results in delaying major disruptions and may help to produce a more gradual adaptation of the workforce in these countries. However, the possibility for major labour disruptions in developing countries should not be discounted.

A more general concern with AI advances relates to the impact on the developmental gap between rich and poor countries. The latest technological breakthroughs and applications occur in the a few countries in the developed world. The developing world, on the contrary, is at risk of being left behind in the AI revolution. Addressing this challenge is important, as AI can help improve the humanitarian situation, support disaster relief, alleviate lack of resources and spur economic growth (via the application of smart agriculture for example).

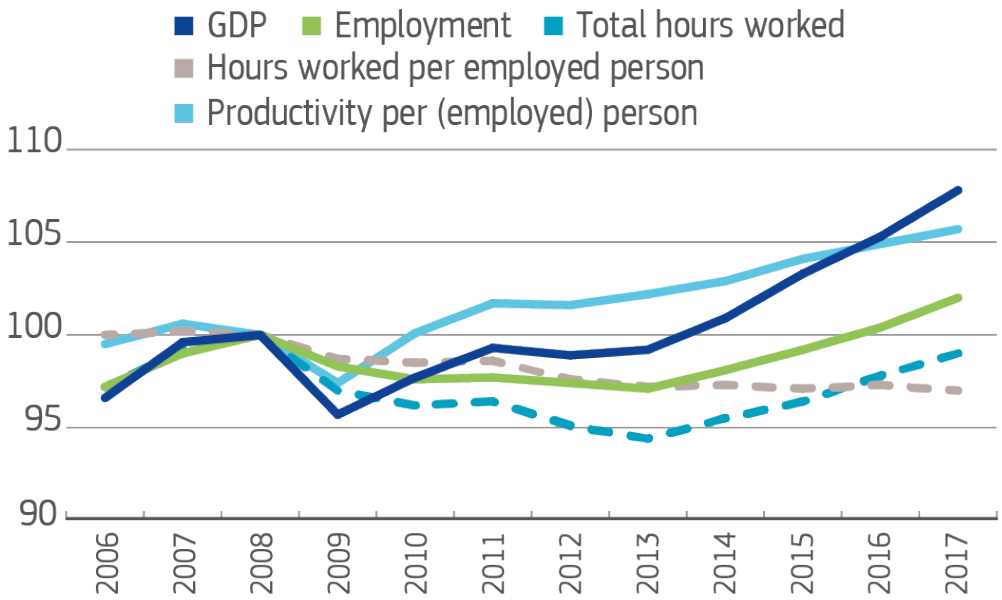
Whether automation will be more disruptive to the labour markets in developed or developing economies is not yet clear. One way to look at it is that automation will be driven by its relative cost compared to the cost of labour; hence, developed societies could be considered more at risk of automation. As mentioned above, it seems this risk will be mitigated by demographic developments in these countries. An important implication for the EU is the need to address migration considerations while also attracting talent from abroad (see Chapter 7 on recommendations).

1.2.3. Changes linked to productivity trends

The recovery from the financial crisis has been characterised by a job-rich but a productivity-weak recovery (see Graph 2). In fact, labour productivity growth remains at historic lows in most advanced economies, raising concerns about impact on wages and living standards in spite of major advances in digital technologies. There is a marked disconnect between vanishing productivity growth and rapid technological change. Productivity growth fell on average to 0.5 % in the period 2010-2014 compared to 2.4 % a decade earlier. The waning of productivity growth started in the 1990s and persisted after the financial crisis, certainly caused by continuing weak demand and uncertainty.

Graph 2: Productivity rises slowly in a context of robust output and employment growth, while hours worked per person employed have not rebounded and may be on a long-term decline accelerated by the crisis

Growth in real GDP, real productivity, employment and hours worked (cumulative change - index 2008=100), EU and euro area

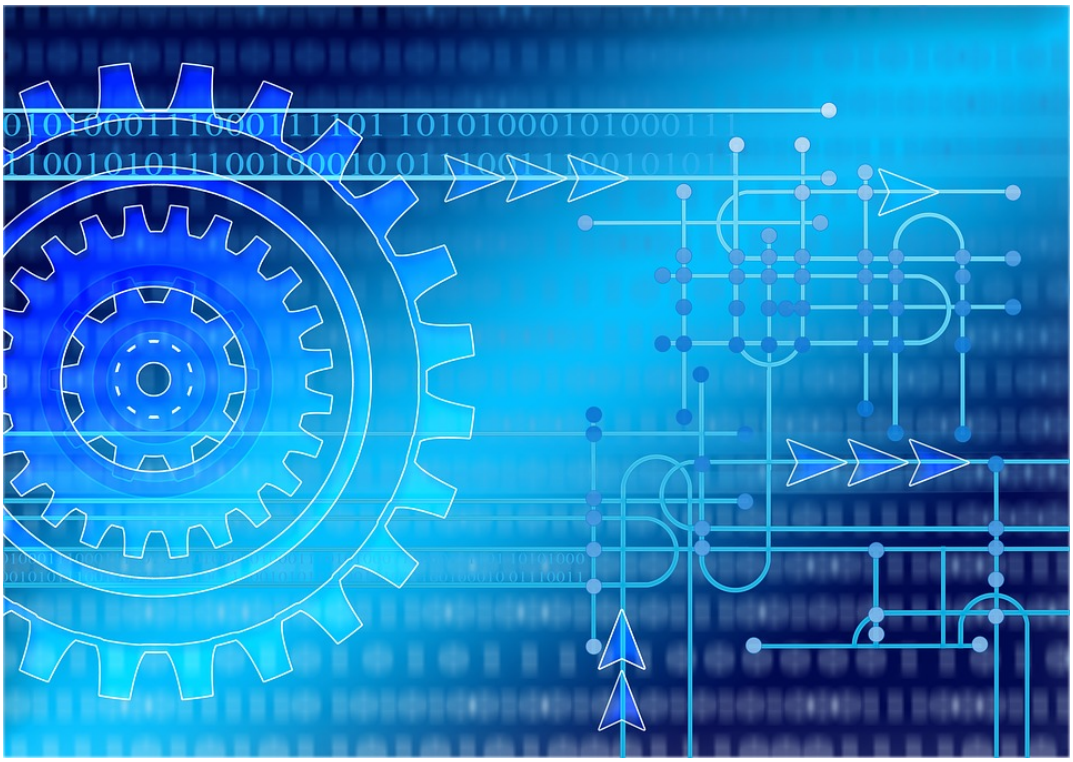


Source: ESDE 2018

This raises questions about (i) the dissemination of new technologies to firms, in particular SMEs, (ii) the market environment able to support the development of the most innovative firms, and (iii) resource misallocations, in particular skills mismatches. Productivity developments are examined in more depth in Section 3.3.

CHAPTER 2

How automation is changing the economy



The chapter at a glance

Have you ever asked yourself what the difference is between digitalisation, robotisation and the increased uptake of AI technologies? Where do you draw the line between these phenomena?

If you have, you will probably have realised that it is hardly possible to distinguish their respective impacts on labour markets from one another. The deployment of automation technologies and artificial intelligence builds upon and is enabled by the different components of the digitalisation of the economy, such as mobile internet connections, widespread use of smartphones and laptops, and cloud computing.

This chapter defines the main automation technologies affecting the economy. AI and automation are not new phenomena. Physical robots have been utilised in manufacturing for quite some time, but they are now becoming much more capable, flexible, safer and cheaper. Likewise, AI is not new but the pace of recent progress is.

To place the impact of AI and robotics on labour markets, the chapter examines how the digital revolution has affected jobs, traditional industries, the development of new services and forms of work, and the transformation of firms.

2.1. Definitions of the main automated technologies affecting the economy

In practice, it is not easy to separate AI, robotisation and digitalisation as they are embedded in the same products and services and are interconnected. Therefore, it is hardly possible to distinguish their respective impacts on labour markets from one another. The deployment of automation technologies and artificial intelligence builds upon and is enabled by the different components of the digitalisation of the economy, such as mobile internet connections, widespread use of smartphones and laptops, and cloud computing. This report looks at **digitalisation** as an enabling factor for automation (as an intermediary stage with less disruptive effect on labour markets) and **artificial intelligence** as a potential game-changer for some industries and occupations.

Artificial intelligence refers to systems that display intelligent behaviour by analysing their environment and taking actions - with some degree of autonomy - to achieve specific goals. AI-based systems can be purely software-based, acting in the virtual world (e.g. conversational assistants, image analysis software, search engines, speech and face recognition systems) or can be embedded in hardware devices (e.g. advanced robots, autonomous cars, drones or internet of things applications).

Already today, AI is used by workers on a daily basis, for example, radiologists use it to detect tumours more accurately by instantly comparing x-rays with a large amount of other medical data.

Artificial intelligence in the form of machine learning requires three essential elements:

1. Access to a large pool of data: this is the fundamental difference with digitalisation, where automation is based on rules introduced in a computer that simply executes permanent instructions; in the case of machine learning, the system depends on a large pool of data to train itself and deliver an objective pre-determined by humans.

2. Products and services in which artificial intelligence can be embedded to improve productivity in the production process or quality of outcome for consumers.

3. Performing chips: growth in computing power, availability of data and progress in algorithms have turned AI into one of the most important technologies of the 21st century.

AI and automation are not new phenomena. Physical robots have been utilised in manufacturing for quite some time, but they are now becoming much more capable, flexible, safer and cheaper. An example is Kuka's flexible matrix production system, which enables customised production, as different products can be manufactured on the same system[6]. As

6 https://www.kuka.com/en-de/industries/solutions-database/2016/10/matrix-production. Last accessed on 20 March 2019.

already pointed out above, AI is not new but the pace of recent progress is. AlphaGo, the computer system Google engineers trained to master the ancient game of Go, displayed unmistakable signs of creativity when it placed one of its stones in a non-traditional spot on the board that surprised those watching, a move which later proved to be decisive. The potential labour market impact of AI developing creative capabilities is noteworthy, given that jobs requiring creativity are traditionally considered as immune to automation.

Box 1: Common terms used in artificial intelligence

Algorithm
A series of instructions for performing a calculation or solving a problem, especially with a computer. They form the basis for everything a computer can do, and are therefore a fundamental aspect of all AI systems.

Expert system
A computer system that mimics the decision-making ability of a human expert by following pre-programmed rules, such as 'if this occurs, then do that'. These systems fuelled much of the earlier excitement surrounding AI in the 1980s, but have since become less fashionable, particularly with the rise of neural networks.

Machine learning
One particular form of AI, which gives computers the ability to learn from and improve with experience, without being explicitly programmed. When provided with sufficient data, a machine learning algorithm can learn to make predictions or solve problems, such as identifying objects in pictures or winning at particular games, for example.

Neural network
Also known as an artificial neural network, this is a type of machine learning loosely inspired by the structure of the human brain. A neural network is composed of simple processing nodes, or 'artificial neurons', which are connected to one another in layers. Each node will receive data from several nodes 'above' it, and give data to several nodes 'below' it. Nodes attach a 'weight' to the data they receive, and attribute a value to that data. If the data does not pass a certain threshold, it is not passed on to another node. The weights and thresholds of the nodes are adjusted when the algorithm is trained until similar data input results in consistent outputs.

Deep learning
A more recent variation of neural networks, which uses many layers of artificial neurons to solve more difficult problems. Its popularity as a technique increased significantly from the mid-2000s onwards, as it is behind much of the wider interest in AI today. It is often used to classify information from images, text or sound.

Source: House of Lords (2018).

Artificial intelligence can be viewed as 'general' or 'narrow' in scope. General artificial intelligence refers to a machine with broad cognitive abilities, which is able to think, or simulate convincingly, all of the human intellectual capacities and potentially surpass them — in practice, it would be intellectually indistinguishable from a human being. Narrow AI systems perform specific tasks which would require human-level intelligence; it may even surpass human abilities in these areas. However, such systems are limited in the range of tasks they can perform. Most of the panic about dramatic labour market disruptions seems to be driven by the perception of general AI coming to replace workers, while in fact it is much narrower AI systems that are currently being developed and implemented.

General AI, when it is reached, will be a much more disruptive event with unforeseeable consequences for labour markets and society in general (hence, the term 'singularity', which is often used to refer to general AI). Looking at its effects on labour markets is thus a much more speculative exercise and beyond the scope of this report, which only considers the impact of narrow AI.

When it comes to robotics, this report uses the definition of the International Federation of Robotics, according to which an industrial robot is 'an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications'. As pointed out by Bruegel (2018), while our coffee machine, or the elevator at our home building, does not fall under this definition, fully autonomous machines that can be programmed to perform several manual tasks without a human operator, such as welding, painting, assembling, handling materials or packing, are classified as industrial robots.

Box 2: New technologies and the digital transformation

While at the forefront of the digital transformation, AI and robotics are not the only technological developments driving it. Other new technologies also promise to push forward the digital frontier and some have already started doing so. Some of these technologies are mentioned below.

The internet of things

The internet of things (IoT) is the network of physical devices, such as home appliances or vehicles, and other items, which include electronic components, software and sensors. They are interconnected, which allows the devices to collect and exchange data. This connectivity in turn creates opportunities for more direct integration of the physical world into computer-based systems and can result in efficiency improvements and economic benefits. As of 2017, there were 8.4 billion IoT devices; their number is projected to grow to 30 billion by 2020, bringing their global market value to USD 7 trillion.

Blockchain technology

A blockchain comprises a list of records, which are cryptographically linked. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data. By design, a blockchain is resistant to data modification. It is 'an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way'[7]. When used as a distributed ledger, it is typically managed by a peer-to-peer network, which collectively adheres to a protocol for inter-node communication and validating new blocks. Once recorded, the data in any given block cannot be altered retroactively without alteration of all subsequent blocks. This requires consensus of the network majority. While not unalterable, blockchain records may be considered secure by design. The most well-known examples of a blockchain technology in practice include cryptocurrencies, such as Bitcoin.

Source: https://en.wikipedia.org/wiki/Blockchain

New and advanced materials

Materials that are utilised in high-technology applications are termed as advanced materials. These advanced materials are typically traditional materials whose properties have been enhanced, and also newly developed, high-performance materials. Furthermore, they may be of all material types (e.g. metals, ceramics, polymers), and are normally expensive. Advanced materials include semiconductors, biomaterials, smart materials and nano-engineered materials.

A number of these advanced materials are used for lasers, integrated circuits, magnetic information storage, liquid crystal displays (LCDs) and fibre optics.

Source: https://www.quora.com/What-are-the-types-of-advanced-materials

Autonomous devices

Autonomous devices are aware of their environment, their state and incoming data and have the ability to learn and make decisions on their own. These include AI-enabled devices such as self-driving vehicles and smart appliances, which can proactively interface with the world and establish a more intelligent and autonomous ecosystem.

7 Iansiti, Marco; Lakhani, Karim R. (January 2017). "The Truth About Blockchain". Harvard Business Review. Harvard University.

2.2. A look at digitalisation, automation and recent labour market transformations

As the report already surmised above, the digital revolution, which started in the 1960s, offers the best approximation of what the expected impacts of AI and robotisation on labour markets can be. It is therefore useful to take a more in-depth look at recent labour market transformations spurred by the advent of computers, smartphones and mobile internet connectivity.

2.2.1. Massive job creation in the IT sector

Looking at the figures, digitalisation has resulted in massive job creation: in fact, it has created over 2 million jobs in the EU in the last decade - 1 million from 2013 to 2016 alone[8]. In the IT sector, we now see skills shortages and the forecast is that 800 000 more workers will be needed by 2020.

Cedefop, the European Centre for the Development of Vocational Training, expects that between 2016 and 2030 there will be over 151 million job openings, with 91 % being created due to replacement needs and the remaining 9 % due to new job openings. In the same period, there will be over 1 750 000 job openings for ICT professionals. For comparison, the total employment in this occupation was 3 868 569 people in 2016[9].

2.2.2. Transformation of traditional industries

Calculating the digital revolution's overall net effect on job creation (and hence surmising AI's potential) means looking at both the augmentation and disruption potential of technologies. New (digital) technologies not only destroy some jobs, but, in most cases, also augment current jobs and create new jobs in different economic sectors. To present the full picture, we therefore need to focus on the overall economy. As we saw above in the case of the digital revolution, many more new jobs were created than destroyed. Human computers might have been replaced by machine computers, but many new jobs in different sectors were created at the same time.

We already explored the positive interplay between the three key factors of economic transition above. Digitalisation being one of them, it has a huge impact on traditional industries, which is overall positive. Productivity is increasing because of digitalisation: the result is jobs coming back in car manufacturing and the textile sector in Europe. Relocation is becoming reality. Recent studies[10] estimate that digitalisation in existing industries will add over EUR 110 billion of revenue per year in the EU until 2020.

8 ESDE 2016
9 EU Skills Panorama. http://skillspanorama.cedefop.europa.eu/en
10 See for example PwC (2015) and Boston Consulting Group (2015)

When the declining cost of machines puts at risk low-skill jobs intensive in routine tasks, above all in the standard manufacturing assembly sectors, it also means that companies will prioritise sophisticated tasks generating more economic value closer to customers. These will be located where skills are, and lead to an increase in large numbers of high-skilled jobs in Europe and other developed economies. With the right type of transition support, job automation can lead to increases in the quality of jobs and responsibilities for workers.

In 2017, 3D printing technology enabled Adidas to establish two speed factories in Germany and the US, eliminating more than 1 000 jobs in Vietnam (see case study on shoe manufacturing). In 2013, Philips shifted its production of electric shavers back to the Netherlands due to rising wage costs in China, high turnover of employees and the concomitant increase in personnel training costs.

2.2.3. Digitalisation and the development of new services

Coming back to the discussion on disruption and augmentation and the necessity to focus on the overall economy when assessing the impact on jobs, e-commerce is a good case in point. It is now a key component of the economy, alongside physical trade. While traditional brick and mortar retailers might have suffered, e-commerce has meant new job in logistics, marketing, product design, etc. We also see the emergence of new services and new industries: Amazon, Spotify and Netflix have all resulted in innovation.

For instance, after Amazon introduced robots to carry out heavy lifting in its logistic centres in the US, it also added 80 000 warehouse workers. Overall, the share of US work hours in the service sector grew by 30 % between 1980 and 2005 after being flat over the 30 years before. These examples serve to prove the potential of AI and automation for creating new jobs and services and bringing about economic and societal gains.

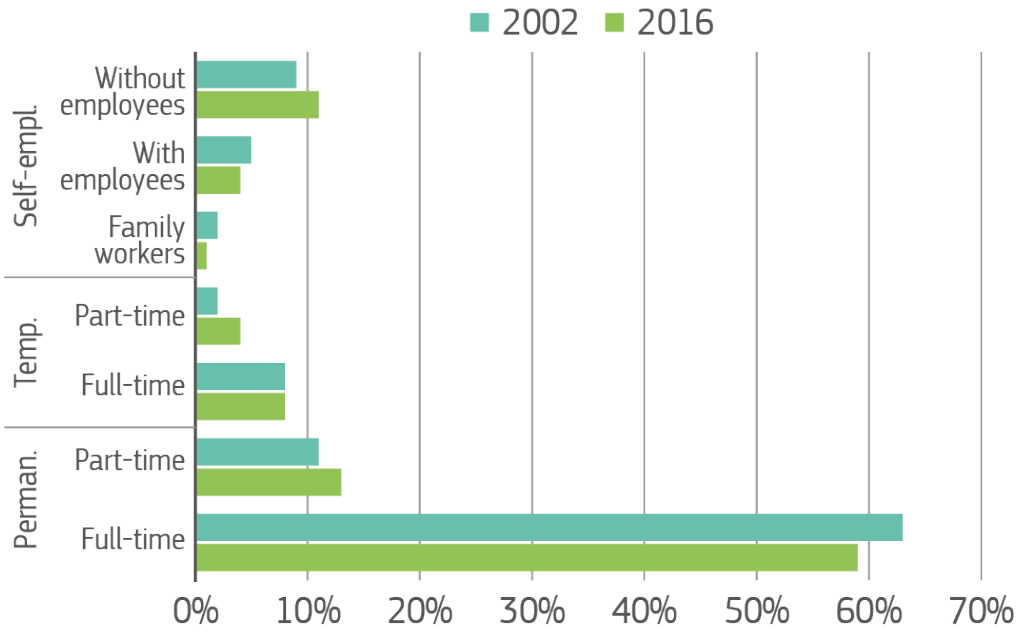
2.2.4. Emergence of new ways of working

The new ways of working spurred by the digital revolution have important policy and societal implications. A growing number of workers are engaged in non-standard forms of work: temporary, part-time and on-call work, temporary agency work, and self-employment (see Graph 3). Even though these workers remain a minority, in advanced economies about 60 % of all employment growth since the 1990s constituted non-standard work[11].

11 EPSC 2018a

Graph 3: Permanent full time employees still is the largest part by far, but decreasing

Employment relationships - shares in 2016 and 2002



Source: ESDE 2018

One of the best examples of how digitalisation has affected the world of work is the emergence of digital platforms. Platforms change labour market boundaries and relations within some sectors. They are digital networks that coordinate transactions in a digital market place. This is a new form of organisation that does not fit neatly in the existing categories of dependent or self-employment, and raises some questions as to the collective representation and the nature of contractors' participation. For instance, Uber calls their drivers 'clients', but at the same time is putting in place many measures to provide them with training possibilities and social protection.

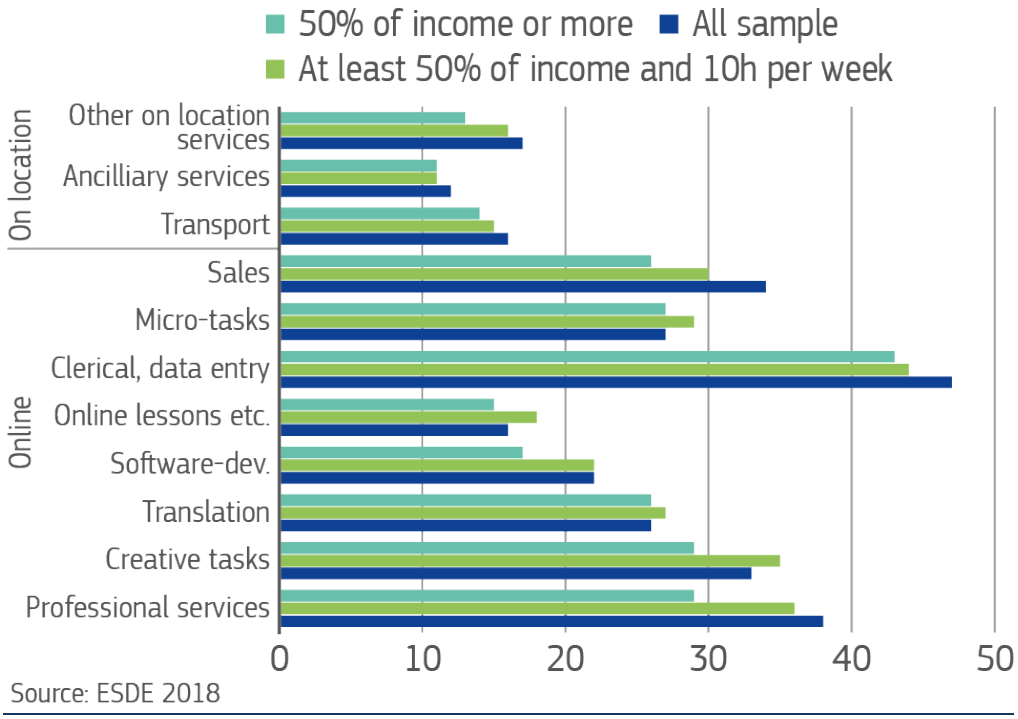
The rise of digital platforms allows consumers to buy cheaper and easier many household and personal services, such as meals ordered online and delivered by hand. McKinsey (2017b) has found that such platforms result in an increase in employment in the industry, both for traditional workers providing those services and for the newly self-employed workers on the platform. Some examples of platform work include services provided from home (like Twago or Clickworker), mobility services (i.e. Uber), or services working in somebody else's home (i.e. Taskrabbit).

Platform workers provide a wide range of services (see Graph 4), typically performing a limited number of tasks. Close to 40 % of them perform one task only, 20 % perform two tasks and 15 % three tasks. As the 2018 Employment and Social Developments in Europe review (ESDE) points out, the tasks most commonly performed are clerical (including data entry, transcriptions and customer services), professional (including accounting, legal

services and project management), sales and creative tasks. Some of these tasks are susceptible to automation by employing AI, especially data entry, transcription and customer services.

Graph 4: Platform workers most commonly provide clerical or professional services

Types of services provided, by whether online or on location



Source: ESDE 2018

The advent of digital platforms makes some types of work (such as home cleaning, grocery delivery, or accounting) more accessible to every individual. Improved access to digital infrastructure (such as laptops, tablets, and smartphones) enables on-demand services to boom. Platforms make it easier to sell products and services, enable distant and part-time work to provide services, and enable the use of dormant assets (Air BNB, BlaBla car, Uber, etc.). This provides a unique opportunity for the labour market to be accessed by parts of the population on the margins of it, for instance people with disabilities. Furthermore, it is a way to formalise the informal economy: indeed, in many cases, the services that are offered on the platforms (e.g. cleaning, DIY, lawn mowing) were performed before in an informal manner. However, there is also evidence that gig work can exacerbate gender and race-based discrimination by sidestepping legal protections and screening processes[12].

Only a minority of platform workers make a living from such work, and very few people draw more than half of their income from such activity. According to ESDE (2018), one

12 https://qz.com/work/1170830/the-gig-economy-exacerbates-gender-discrimination-a-study-shows/. Last accessed on 20 March 2019.

survey indicates a range from 0.6 % of the adult population in Finland to 4.3 % in the UK, and an average of 2.3 % across 14 EU countries. Those numbers are in line with recent US estimates, which indicated that in 2016, less than 1 % of the US workforce derive their main source of income from such a platform.

Putting aside the number of people employed, the overall size and number of digital platforms are growing. ESDE (2018) presents recent estimates which indicate that the monetary value of transactions within collaborative platforms grew by 56 % between 2013 and 2014. The following year, transactions increased by a further 77 %. These estimates include accommodation and financial services as well as transportation, household and professional services. The latter three labour-intensive categories comprise about 28 % of transactions. There is little doubt that we are seeing an upward trend in services demanded and provided online.

As we already pointed out above, digitally enabled independent work is increasing. McKinsey (2017d) indicates that 20 to 30 % of the working-age population in the US and Europe is engaged in independent work. Just over half of these workers supplement their incomes while having traditional jobs, or are students, retirees or caregivers. While 70 % choose this type of work voluntarily, 30 % use it as a necessity because they cannot find occupations that meet their income or flexibility needs. The proportion of independent work conducted on platforms is about 15 % today, but growing rapidly. Those who pursue it as a necessity are generally unsatisfied by the income variability and the lack of social benefits.

Platform workers might not necessarily gain access to vocational training or protection options as this exposes platforms to reclassification as employers. This issue was addressed in France in August 2018 when the French National Assembly proposed a law reforming vocational training and unemployment, with the aim of better securing career paths. Under the proposed law, platforms will be able to provide further support to workers such as vocational training or offering protection options without being exposed to reclassification risks. As set out in the law, platforms are required to draft their own social charter setting out concrete steps on how they will fulfil their social responsibility. The charter contains eight chapters covering different areas including working conditions, vocational training, social protection and the commercial worker-platform relationship. The content and implementation of these eight chapters cannot serve as indications of an employment relationship.

Modern forms of workers' organisation, such as digital freelancers' unions and updated labour market regulations, are beginning to emerge to complement the new forms of work. The new organisational models bring new challenges for employers, individuals and governments. One very important challenge to be addressed is finding ways to ensure that the changing nature of work benefits everyone. For policymakers, this means addressing

concerns about the portability of safeguards and benefits between jobs and the equivalent treatment before the law of the different employment types.

The changes described above signal a profound transformation of the economy. The economy of the last century was dominated by strict work schedules, hierarchies and repetitive tasks: a job meant a permanent contract attaching a worker to a firm. Today, work relations are becoming more fluid. They are based on peer-to-peer transactions and flexible work arrangements, and are driven not by tasks but by projects that unite groups of people until they are completed, with the latter then moving to the next project. This is giving a huge bargaining power to individuals (at least to those who have the necessary skills). It also gives power to those whose access to the labour market was previously limited by time constraints (such as mothers or the elderly). People are also empowered to choose the project that they like best and that pays best. People can also negotiate the best conditions for their participation in a project with a firm. This differs from permanent employment, where the workers has to accept the tasks assigned to them. Nevertheless, the more flexible forms of work galvanised by the digital revolution also present challenges and risks (such as ensuring adequate social protection, with 60% of working poor in Europe being on non-standard contracts). These are examined in Chapter 6 below.

2.3 A look at the transformation of firms

The architecture of firms has radically changed over the years because of globalisation and automation. This is intrinsically connected to the transformation of labour markets we are witnessing. Vertical integration, which was the norm in the beginning of the previous century, has been replaced by a wide decentralisation of companies, to the extent that it is sometimes difficult to ascertain their boundaries or even their status.

As pointed out by the World Bank (2018), the Ford Motor Company of the 1930s was fully integrated, owning the plants that manufactured the steel used in the cars, and the sheep farms supplying wool for the car seats. Until recently, the Japanese *zaibatsus* and Korean *chaebols* were fully integrated conglomerates largely dominating their national economies.

Globalisation gradually led to a new organisation of firms, one that is more decentralised and based on the concept of global supply chains. A telling example is IKEA, which procures most of its products from a global network of suppliers. It then sells these products, manufactured to its strict specifications, under its brand in stores all around the world.

Today's corporate structures excel at driving efficiency in static environments such as the workplace, a classroom or even a hospital ward. The hierarchies and bureaucracies that are so commonly used today are all about defining a competitive advantage, dictating a plan and efficiently executing that plan by coordinating activities and driving compliance.

However, in a volatile, uncertain world, where disruption is the new normal, the fundamental plan, prescription and execution systems of the past do not work well. This creates inflexible and inefficient structures incapable of keeping pace with rapid change. Prescribed tasks also drain initiative out of people and prevent them from reacting to disruption.

The integration of artificial intelligence, robotics and automation should cause organisations to become more collaborative and team-oriented, as opposed to the traditional top-down hierarchal structures[13]. Organisations must move away from a top-down structure and become team-centric, optimised for adaptability and learning in preparation for technological disruption.

A key to a new organisation of companies will be introducing a culture of learning throughout the organisation. Furthermore, introducing more agile ways of working will be a high-priority organisational change, as well as more cross-functional collaboration. This means multidisciplinary teams or networks collaborating in rapid learning and fast decision cycles.

Constantly adapting work allocation will be essential to make the most effective use of different qualifications and to develop them. Shifting tasks across workers raises company efficiency and creates more agility. For example, registered nurses and physician assistants now do some of the tasks that primary care physicians once carried out, such as administering vaccinations and examining patients with routine illnesses[14].

This new corporate culture is also made possible by technological advances. The office and the company can be increasingly dematerialised. There is no need for workers to be physically located in the same place when most of the company's operations can take place online.

This is especially true for online commerce. A more recent transformation driven by the emergence of e-commerce and artificial intelligence is the meteoric rise of certain retail firms with a large online presence, replacing or adding to bricks-and-mortar shops. These digital platforms do not consider themselves as firms, but as market places; they see their role as connecting shoppers with vendors and collecting a fee for this. The Alibaba Group is one very telling example of this new architecture. Thriving on the technological advances of artificial intelligence, in particular thanks to the data it is collecting on shoppers, it rose quickly to become a global company, managing this in less than 10 years (it took IKEA more than 40 years to become the brand it is today). It has a relatively limited workforce, and diversifies its income sources to include various services provided to shoppers, in particular financial services.

13 https://www.fastcompany.com/3068492/how-ai-is-changing-the-way-companies-are-organized. Last accessed on 20 March 2019.
14 https://www.mckinsey.com/featured-insights/future-of-work/skill-shift-automation-and-the-future-of-the-workforce. Last accessed on 20 March 2019.

This means that physical presence is no longer a requirement to do business or to work. Freelancers have access to multiple platforms where they can offer their services; firms can provide their services or offer their products without any physical presence. The positive aspect is the possibility for underused human capacity to be mobilised and to generate income, as well as for firms to establish a market presence at a reduced cost.

One problematic issue is where and how such digital businesses should be taxed, which is directly connected to the redistribution of the value created, in particular to the workers/freelancers (and their families) who work for these digital firms. While it is clear that the current tax rules based on source and residence have reached their limits in this context, it is less clear what the solutions should be to ensure fairer taxation, to limit tax avoidance, and to allow redistribution of incomes towards specific areas raised in this report, in particular education, work transitions and social protection. Different solutions are being considered, such as value added tax, creating a self-standing levy on digital services or introducing anti-diversion rules. However, these all require some international understanding and cannot be effective if they are limited to unilateral steps taken by some governments. These aspects are further examined in Section 6.3 below.

There are also important geostrategic implications resulting from Europe's small relative share in the online platform economy. While the growth of the platform economy continues, Europe's platform companies make up just 3 % of its value. The United States have a share of 67 % while Asia has already reached a share of 30 % of the value of the 60 most valuable platforms. This is problematic for Europe, given the growing importance of the online platform economy. In the first half of 2018, the 60 most valuable platforms in the world gained around a trillion dollars in value. At the top of the winners list are Amazon, Microsoft, Alibaba, Ant Financial and Netflix. Together, these 60 platform companies are worth several trillion dollars. In Europe, Spotify, Wirecard and Adyen have performed well, but are still far behind the rivals from America and Asia in the overall standings.[15]

The US predominance in the online platform economy is largely driven by a strong entrepreneurial culture and an industry-driven push coupled with a lack of regulation. In China, on the other hand, digital platforms growth is supported by a focused and strategic industrial policy. A particular example is the 'New generation artificial intelligence development plan', which outlines China's strategy to build a domestic AI industry worth nearly USD 150 billion in the next few years and to become the leading AI power by 2030. In Europe, initial steps have been taken to develop an ambitious AI-powered innovation policy, with the coordination action plan on AI launched in December 2018. However, the absence of a strategic industrial policy puts our continent at a disadvantage. On the need for a new industrial policy in Europe, see Section 5.4.

15 https://www.netzoekonom.de/2018/06/24/wert-der-plattform-oekonomie-steigt-im-ersten-halbjahr-um-1-billion-dollar/. Last accessed on 20 March 2019.

AI has started to transform the organisation of companies, but this transformation process is by no means complete. As further elaborated in Section 3.3, the vast majority of firms are either running some pilot schemes, which do not end up getting incorporated into day-to-day activities, or are not considering taking up AI at all. An AI diffusion gap can thus be observed, with only about 20 % of firms being early adopters of technologies such as AI. This has implications for productivity growth, but also the development of the SME sector in Europe (see also Section 5.2).

Case study: A look at AI and the transformation of public administrations

AI holds the potential to improve government operations significantly and meet the needs of citizens in new ways. These range from traffic management to healthcare delivery to processing tax forms. However, many public institutions are careful about making use of AI because of concerns over bias, privacy, accountability and transparency. Negative incidents have emerged in recent years, which were driven by the use of AI in areas such as criminal sentencing, law enforcement or employment opportunities. Governments do not have the luxury of using inscrutable 'black box' algorithms that are increasingly characterising industry-deployed AI. As citizens progressively demand the same level of service from their governments as they do from companies, public officials will need to identify the specific benefits but also negative consequences that AI-powered tools can bring.

As a result, government interest in AI has increased in recent years. Public administrations and large NGOs are starting to invest in AI, spending budget and time on pilot programmes for various AI applications.

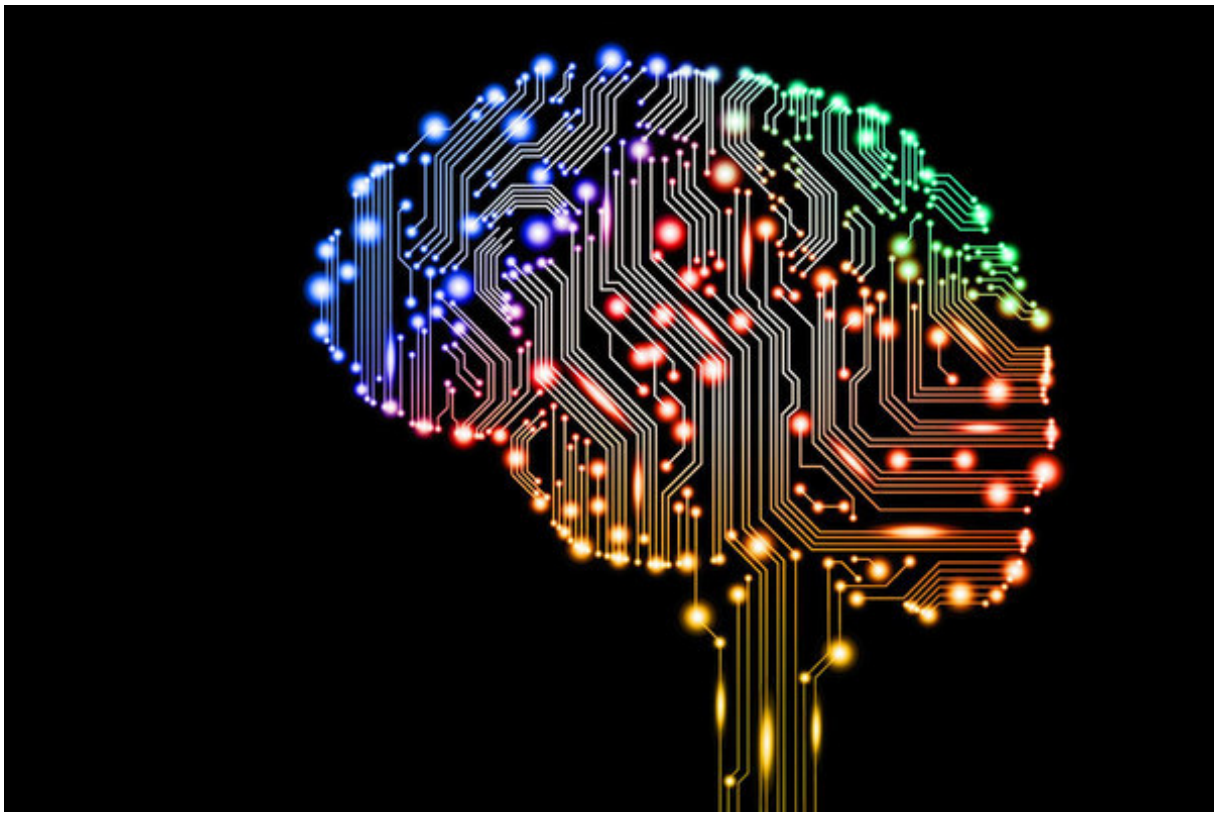
However, such applications in government remain nascent today. Governments may need to overcome several hurdles to successfully adopt the technology:

- Government leaders might need to invest in upgrading their legacy IT systems. Not doing so risks compatibility issues when it comes time to integrate the software.
- Government leaders should make sure their departments have the necessary computing resources for an AI project. Cloud computing solutions may suffice for certain AI applications, but more heavy data crunching might require more expensive graphical processing units.
- Government leaders should be prepared to hire data scientists and subject matter experts that can collaborate to determine the low hanging fruit problems that AI could solve for a given government department.

Sources: https://www.weforum.org/projects/unlocking-public-sector-artificial-intelligence; https://emerj.com/ai-sector-overviews/ai-government-current-ai-projects-public-sector/

CHAPTER 3

AI, ROBOTICS AND THE IMPACT ON LABOUR MARKETS



The chapter at a glance

Have you ever wondered how many existing jobs will be destroyed and new ones created because of AI and robotisation? If you have ever tried to find a precise and unequivocal answer to this question, you will probably have failed.

This chapter examines the impact of AI and robotics on labour markets and jobs. Estimates of the impact vary widely, with between 14 % and 47 % of jobs being considered at risk of automation. The overall impact is determined by the technologies' job destruction and job creation potential. The result of the interplay between both effects is very hard to predict. While exact figures cannot be considered reliable, the existing literature agrees that the effect on jobs will be significant.

The existing evidence also suggests that analytical, administrative and clerical jobs with highly repetitive or rules-based tasks can be automated relatively easy. The

chapter examines this finding through the lens of several case studies, which illustrate how AI and robotics can affect certain jobs (and sectors).

A key component of understanding the impact of AI and robotisation on employment, wages and living standards is how these technologies will affect productivity growth. The chapter looks into the 'productivity paradox' and suggests explanations for why productivity is not growing as fast as it should be.

While the chapter understandably cannot provide a clear-cut answer to the above question, it does elaborate on the factors that have an influence. It also points out that one factor will be crucial in making the overall impact of AI and robotisation on the future of labour in Europe a positive one. This is successfully managing the ensuing labour market and societal transitions.

There are many 'doom and gloom' discussions about massive labour market disruptions caused by the increased uptake of AI and robotisation. Rather than causing entire jobs to disappear, we think the new wave of automation will mostly affect specific tasks within jobs. The content of jobs will change and new tasks will be created as AI augments the human component, rather than destroying the job altogether - at least in the short term.

Estimates of the impact of automation on jobs vary widely, from 14 % to 47 % (see summary in Table 1 below). While most estimates appear to have a sound scientific basis (see more about some of the major studies below), there is a considerable inconsistency among the results of the various studies, which undermines their overall credibility.

When looking into the labour market impact of AI and robotisation, there are two competing effects we need to consider. Automation can directly displace workers from performing specific tasks (displacement effect). However, it can also expand labour demand through the efficiencies it brings to industrial production (productivity effect). The result of the interplay between both effects predetermines the overall impact on jobs and is very hard to predict (as the diverging estimates below seem to suggest).

Bruegel (2018) studies the impact of industrial robots on employment and wages in six European Union countries[16] that account for 85.5 % of the EU market for industrial robots (see Graph 5). They find that one additional robot per thousand workers reduces the employment rate by 0.16-0.20 percentage points. Thus a significant displacement effect dominates. The study also finds that the displacement effect is particularly strong for medium-skilled workers and for young cohorts.

16 Finland, France, Germany, Italy, Spain and Sweden

Table 1: Everything you wanted to know about who predicts what on the impact of automation

	Perspective 1	Perspective 2	Perspective 3	Perspective 4
	Bid your job farewell	**Keep calm and carry on (but do keep an eye on inequality)**	**Few occupations will be entirely automated, but all jobs will be affected**	**The rise of the industrial robots**
Scope & background	In their ground-breaking study, Frey and Osborne (2013)[29] were among the first to gauge the **probability of computerisation for 702 occupations in the US labour market** arguing that the potential scope of automation is vast.	The OECD (2018)[30] shifted **attention to the variation between jobs of the same name and assessed which tasks are difficult for computers to carry out**, even in jobs that are most susceptible to automation.	Focusing on the years 2016-2030, McKinsey Global Institute (2017)[31] **used data from 46 countries to break down 800 occupations into more than 2,000 activities.** Based on this breakdown, they determined the capabilities that would be needed by workers or machines for each activity.	Acemoglu and Restrepo (2017)[32] and Bruegel (2018)[33] respectively evaluate **the specific impact of industrial robots on the US economy and on 6 EU countries** that make up 85.5% of the EU industrial robots market.
Their assessment on the impact of automation	**47% of total US employment is at risk.** In the first wave, most workers in transportation and logistics occupations, together with the bulk of office and administrative support workers and production occupations are likely to be substituted.	**14% of jobs in OECD countries are highly automatable** – equating to around 66 million job losses. Occupations with the highest risk typically require basic or low levels of education, potentially furthering labour market polarisation and inequality.	**While less than 5% of occupations consist of activities that can be fully automated, up to 30% of hours worked globally could be automated by 2030.** Physical activities are most susceptible.	**One additional robot per thousand workers reduces the employment rate by 0.16-0.20 percentage points in Europe.** This notable displacement would most impact young cohorts, middle-education workers, and men.

Source: European Political Strategy Centre

McKinsey (2017b) estimates scenarios across 46 countries, which suggest that between almost zero and one third of work activities could be displaced by 2030, with a midpoint of 15 %. The proportion differs widely among countries, with advanced economies more affected by automation than developing ones, reflecting higher wage rates and thus economic incentives to automate.

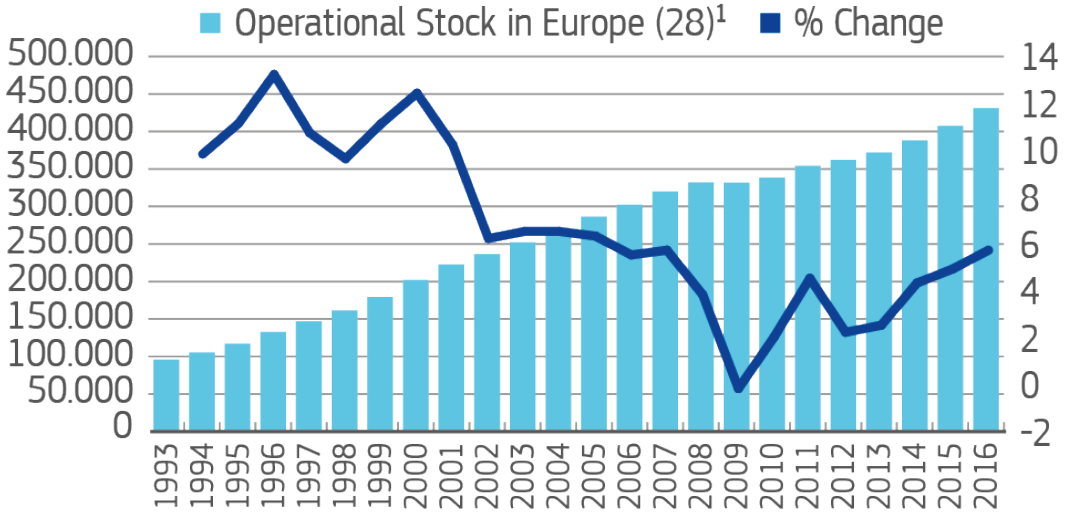
The OECD (2018a) finds that across 32 countries, about one in two jobs could be significantly affected by automation, given the tasks they involve. The degree of risk, however, varies. About 14 % of jobs in OECD countries are highly automatable (with an automation probability over 70 %). This corresponds to over 66 million workers in the 32 countries covered by the study. In addition, another 32 % of jobs have a risk of between 50 and 70 %.

The variance in automatability across countries is large: in the same study, the OECD finds that 33 % of all jobs in Slovakia are highly automatable, but only 6 % of jobs in Norway. In general, jobs in English-speaking and Nordic countries and the Netherlands are less automatable than jobs in eastern or southern European countries, Germany, Chile and Japan.

Unreliable though the figures may seem, job automatability has important repercussions for macroeconomic governance in the EU, as the impact of AI and robotisation on European labour markets will not be homogeneous. As BusinessEurope (2018) points out, digitalisation will affect countries and regions differently, depending on factors such as the current use of digital technology, availability of infrastructure, the skills and education level and composition of the workforce, plus general labour market conditions, potentially raising important questions about economic convergence. The negative effects of automation are likely to hit EU countries like Bulgaria, Romania, or Croatia first – countries which are not technology-rich and have a big part of their large labour force that might be replaced by AI. The different labour market structures in the different Member States, coupled with low labour mobility and a cumbersome EU economic governance system, are a potential recipe for future trouble in the Eurozone and wider EU, should the socioeconomic changes caused by automation exceed expectations. AI could thus undermine EU cohesion and become a tool for massively increasing inequalities - not only within societies, but also between Member States. The impact on the macroeconomic governance of the EU is not the subject of this report, but it is a topic that merits further exploration.

Graph 5: Robotisation is increasing

Level and growth of the operational stock of robots in the EU28



Source: ESDE 2018

3.1. AI-driven changes in current jobs: several case studies

Case study: Healthcare

McKinsey (2017b) estimates that demographic changes could create demand for 51-83 million workers globally, especially in healthcare occupations that focus on taking care of the elderly (home health aides, personal care aides, nursing assistants). The demand for these occupations will grow because of increasing healthcare spending. McKinsey (2017b) points out that the disproportionate cost of healthcare for the elderly means ageing will be the main driver of increased healthcare employment.

AI is traditionally seen as detrimental to jobs in the health sector. AI-enabled new technologies, however, can also help improve the services provided by the industry and the quality of the medical profession. Scaling up and applying AI solutions for more personalised healthcare can lower the costs and increase the availability of proper medical care for certain conditions.

Artificial Intelligence is being deployed to tackle the world's number one killer – heart disease. A team at Stanford University is applying AI-powered algorithms to automate the reading and analysis of EKGs. This could help accelerate and improve the accuracy of arrhythmias diagnoses, freeing up medical staff to focus on more demanding cases or spend more time with patients. AI algorithms can also enable people to monitor their heart rates using built-in sensors on smartwatches. They can even alert people to take an immediate EKG using a smartphone app and a specially designed band with a built-in sensor. In addition, Apple recently released its newest smartwatch, which can take EKG and is certified by the US Food and Drug Administration (FDA), the first wearable device to achieve this.

Another example is the use of artificial intelligence to diagnose certain conditions. In April 2018, the FDA approved an AI algorithm which detects possible cases of diabetic retinopathy from images of the eye. Diabetic retinopathy, a major cause of blindness, is a medical condition in which diabetes causes damage to the retina.

Case study: Shoe manufacturing

Global shoe manufacturers are relocating from south-east Asia back to western factories. At the end of 2015, Adidas opened a brand new, heavily automated factory in Ansbach, Germany. Speedfactory, as it is called, combines a small human workforce with technologies including 3-D printing, robotic arms and computerised knitting to make running shoes. In the last decade, such shoes were generally mass-produced in countries such as China, Indonesia and Vietnam. The new facility allows for personalised products using customised digital designs, which are

translated into shoes by robots. By cutting the distance and hence delivery times to European markets, this new manufacturing technique enables Adidas to react to customer needs within days. In April 2018, another Speedfactory started work in Atlanta, USA. It uses a fully automated digital manufacturing process. By 2020, Adidas aims to create a total of one million pairs of shoes a year in its two Speedfactories. By comparison, in 2017 it manufactured 403 million pairs of shoes - more than a million a day on average.

Case study: Automation and car manufacturing

The automotive industry is already one of the most heavily automated industries (see Graph 6 below), with the fourth industrial revolution (Industry 4.0) anticipated to increase the number of robots in car manufacturing even further. The German car industry is at the forefront of Industry 4.0, introducing small-scale collaborative robots on the assembly line for the first time.

In the past robots took over monotonous or hazardous tasks from human workers. Now, however, German car manufacturers are introducing robots that will collaborate with humans, acting as helpers.

Audi was one of the pioneers of the new technology, introducing a robot that hands coolant expansion tanks to line workers at its Neckarsulm production facility. Volkswagen has also employed similar helper robots to assist during car assembly, as have Mercedes-Benz and Opel.

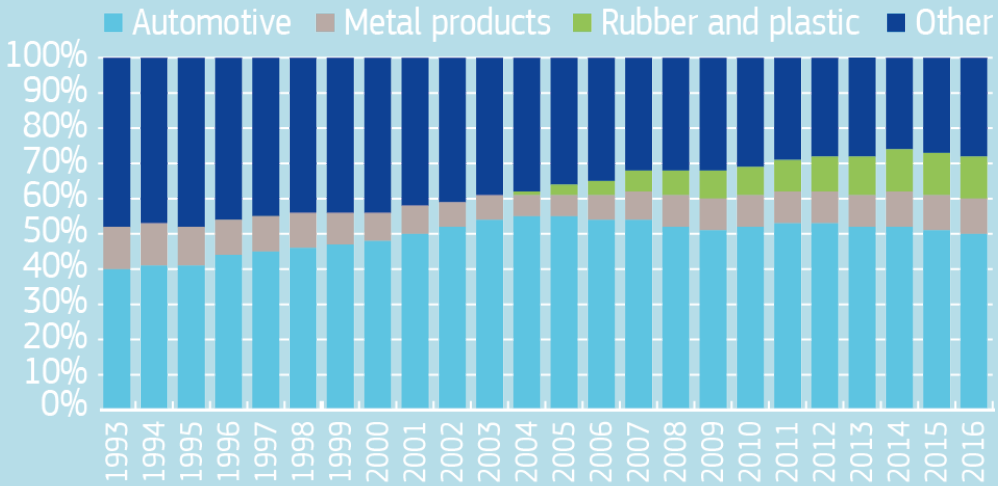
The introduction of helper robots is necessary for German companies, which are they are facing a looming shortage of workers and an ageing population. In addition, German carmakers are hoping new types of robots will spur productivity growth, as Germany's automotive industry is starting to fall behind South Korea, and is facing a potential threat from China.

Despite a common belief that automation eliminates jobs in the automotive industry, the opposite is happening in Germany and other countries. Between 2010 and 2015, the German automotive industry's workforce expanded by 14 %, reaching 710 000 by 2015.

Source: Industry 4.0: German Car Industry Introduces Collaborative Robots. https://blog.euromonitor.com/2016/10/industry-4-0-german-car-industry-introduces-collaborative-robots.html

Graph 6: The automotive sector is the main user of robots within manufacturing

Main sectors using industrial robots - Operational Stock (% of total manufacturing), EU



Source: ESDE 2018

3.2. Impact of automated technologies on jobs

While the exact figures quoted above do not seem particularly reliable, given the wide disparities between them, it is still clear that automated technologies are like to have a significant effect on jobs. For Europe's five largest economies — France, Germany, Italy, Spain and the United Kingdom, McKinsey (2017a) estimates that about USD 1.9 trillion in wages and 62 million workers are associated with technically automatable activities. As we shall see in Chapter 4, this underlines the necessity to manage transitions.

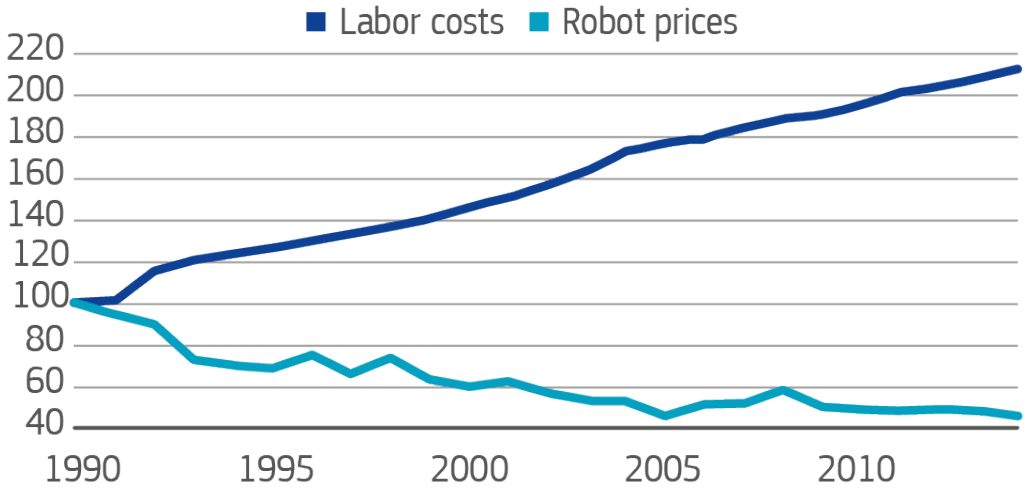
The report has already mentioned that the extent of the impact on labour markets will depend on how far and how fast AI technology develops and is adopted. To give one example, as robot dexterity improves, jobs currently perceived as having little automation potential may undergo further labour displacements. Advances in this field appear to be on the rise. Dex-Net, a robot developed at UC Berkeley, is much closer to matching the adroitness of a human than anything developed previously. Its software tries to pick up objects in a virtual environment, training a deep neural network through trial and error. Very importantly, Dex-Net can apply knowledge of an object it has seen before to a new one (generalisation). The robot will even nudge an item to get a better look if it is not sure how to grasp it. To measure the dexterity of a picking robot, UC Berkeley has also developed a metric called 'mean picks per hour' - calculated by multiplying the average time per pick and the average probability of success for a consistent set of objects. Humans are capable of between 400 and 600 mean picks per hour, while standard robots can manage between

70 and 95. Dex-Net manages 200 to 300 mean picks per hour, and its creators expect it to attain or even surpass human levels within five years[17]. In other areas, automation technologies have already surpassed human capability levels. Error rates for image labelling have fallen from 28.5 % to below 2.5 % since 2010[18]. Despite these improvements, humans are still needed to supervise robots: when Amazon added robots to its US operations to perform heavy lifting tasks, it also added 80 000 warehouse employees.

A key factor influencing the impact of automated technologies on jobs depends on the uptake of these technologies, which in turn is affected by the relative cost of replacing workers with technology. In 2010, the estimated payback period in China was 5.3 years. This has fallen to 1.5 years by 2016, influenced by falling prices of robots and rising labour costs[19] (see Graph 7).

Graph 7: Labour costs are increasing while robots become ever cheaper.

Robot prices and labour compensation index in the US, 1990=100



Source: ESDE 2018

Moving from the more abstract to the more concrete and looking at the impact of automation and AI on job categories, the evidence suggests that analytical, administrative and clerical jobs with highly repetitive or rules-based tasks can be automated relatively easily. Highly predictable and structured physical activities, digital jobs that do not involve direct contact with customers, entry level jobs or jobs that make heavy use of quantifiable data or codifiable knowledge, also fall within this category. If you are a shop assistant in a

17 https://www.technologyreview.com/s/610587/robots-get-closer-to-human-like-dexterity/. Last accesses on 20 March 2019.
18 AI Index 2017 annual report. https://aiindex.org/
19 Bain 2018

supermarket, for example, you could see your job disappear in the near future (see more in the case study on Amazon Go in Section 3.2.1 below).

When we translate this into the level of skills involved, the evidence suggests that workers in low- and medium-skill jobs are at higher risk of losing their jobs through automation. The OECD (2018a), for instance, points out that the risk of automation is not distributed equally among workers. Automation affects mainly jobs in manufacturing and agriculture, but also some service sectors (such as postal and courier services, land transport and food services). The occupations with the highest automatability typically require only basic to low level of education. Similarly, the least automatable occupations almost all require professional training and/or tertiary education. The unequal distribution of risk among workers points to the potential of new technologies to exacerbate inequality significantly, calling for substantial support in managing the resultant transitions.

3.2.1. Jobs disappearing

Having looked at the impact of AI and robotisation on labour markets from a fairly broad perspective, we now need to ask the question: what specific jobs are at risk of automation?

McKinsey (2017b) identifies the jobs most at risk of automation. These include office support occupations (record clerks, office assistants, finance and accounting), some customer interaction jobs (hotel and travel workers, cashiers, food service workers) and a wide range of jobs carried out in predictable settings (assembly line workers, dishwashers, food preparation workers, drivers, operators of farm machinery and other equipment).

It looks as if many of the middle-income jobs that only required secondary education or less could be displaced significantly by automation. Such occupations include truck drivers and office clerks. Both of these occupations have high technical potential for automation. Moreover, people employed in these jobs currently receive middle-level wages, which raises the economic incentives to automate.

Defining the occupations most at risk of automation is the necessary first step towards preparing labour markets and societies to manage the accompanying transitions. Below is a non-exhaustive list of some of the occupations and economic sectors that face significant labour displacement:

- agriculture: influenced by the development of remotely controlled, self-driving tractors;
- call centres can be replaced by speech recognition software;
- postal service jobs (mail sorters, processors, carriers);
- data entry clerks;

- legal clerks;
- tax accountants;
- truck, taxi, bus drivers;
- shop assistants;
- many more?!

As the report has already pointed out on several occasions, it is very important to focus on the overall economic picture when assessing the labour market impact of AI and robotics. In some industries, workers are replaced altogether by automation. In others, a handful of workers are left alongside robots. The World Bank (2018) found that it costs the equivalent of USD 8 an hour to use a robot for spot welding in the car industry, compared to USD 35 for a worker in Germany and USD 20 for a worker in Slovakia — this gap is most probably only widening further with new technology. While it is much easier to predict what jobs will be destroyed than what new ones will be created, policymakers need to focus on both the destructive and creative capabilities of new technologies when devising strategies to manage the upcoming transitions.

Case study: Impact of Amazon Go on supermarkets

The first Amazon Go shop opened to the public in San Francisco in January 2018. It is a new kind of shop with no checkout required, which basically means no queues, no cashiers and no waiting – to shop you just install the app on your smartphone, generate a barcode on entering the shop, and that's it. You just take whatever you want off the shelves. The shop tracks what you pick up and what you put back. When you have finished shopping, you just leave the shop and then receive a receipt shortly after. Amazon Go uses the same type of technologies as in self-driving cars - computer vision, sensor fusion and deep learning. While there are no cashiers, a team of workers works in the kitchen and the shop to prepare ingredients, make Amazon's ready-to-eat food, stock shelves and help customers. Nine additional Amazon Go shops have since opened up in San Francisco, Chicago and Seattle.

Source: Amazon. https://www.amazon.com/b?ie=UTF8&node=16008589011

3.2.2. Jobs transformed

Even when some tasks are automated, employment in the relevant occupations may not decline, rather, workers may perform new tasks. In these sectors, automation augments

and transforms jobs, rather than replacing them, as it allows employees to focus on tasks with higher added value. For example, since the 1980s, 400 000 cash dispensers have been installed in the United States. At the same time, the number of bank tellers has risen from 500 000 to nearly 600 000. One explanation is that cash dispensers have increased demand for tellers by reducing the cost of operating a bank branch. While the average number of tellers required to operate a branch office in urban areas fell by 35 %, the number of bank branches in these areas increased by 43 %[20].

Bain (2018) points out that although automation seems to affect mainly low-skilled jobs, it can also affect some well-paid service sector jobs. For example, law firms are already using algorithms to scan legal documents instead of using highly educated and paid junior lawyers. Algorithms are also used to automate tasks in labour-intensive financial services – such as mortgage loan processing. While it is still not possible to quantify the effect on the number of loan officer jobs, anecdotal evidence seems to suggest that the effect will be the same as with bank tellers - AI is reducing the amount of time the loan officer spends processing customer details so he or she can spend more time advising the customer. Rather than removing loan officers from the transaction, automation puts them at its centre.

The OECD (2018a) presents another example of automation freeing up human resources within the same jobs. This also applies to scientists, who are more productive now than three decades ago because computing software performs the time-consuming calculations required by data analysis. In this example and the previous ones in this section, artificial intelligence is used to augment rather than replace humans in their jobs.

3.2.3. Existing jobs which will grow in number

Without the proverbial crystal ball, it is very hard to pinpoint what new jobs will emerge from AI and robotisation. However, the idea that some existing jobs will grow in number seems to make sense.

Some jobs will grow in importance and number because they cannot be automated, requiring specific skills that are inherently human. These skills include:

- social intelligence, the ability to negotiate complex social relationships, e.g. caring for others or managing cultural sensitivities;
- cognitive intelligence, such as creativity and complex reasoning in an artistic context (early signs of the creative capability of AI technologies, such as AlphaGo (see above) are noteworthy in this regard);

20 OECD 2018a

- perception or manipulation, as the ability to carry out tasks in an unstructured or unpredictable environment (improvements in sensors and computer vision could enhance robots' dexterity, thereby challenging jobs hitherto considered as shielded from automation).

Overall, and in the most likely scenario, jobs requiring coaching, caring or creativity will not be affected by artificial intelligence or extensive automation. Automation will have less effect on jobs that involve managing people or applying expertise, and those involving social interactions, where machines cannot yet match human performance. Jobs in unpredictable environments (gardening, plumbing, childcare and care of the elderly, for example) will probably also see less automation by 2030, as they are technically difficult to automate and often offer relatively lower wages. Also, even AI and robotisation have some limits in the tasks they can take on, as was shown recently by the example of two robots which were taught to assemble an IKEA chair[21] and finally took three times as long as a human. This makes automation less attractive.

However, the potential for technological breakthroughs to challenge previous ideas of certain jobs as being shielded from change should not be totally discounted. For example, recent advances in robotics[22] suggest that occupations where emotional intelligence plays an important role (such as childcare or care of the elderly) might not be as automation-proof as previously thought. Replacing humans in these occupations is probably still at least a decade away (if feasible at all), but such developments show that no occupation can be considered safe.

Looking across all the countries covered by the study, McKinsey (2017b) finds that the categories experiencing the highest growth due to automation include: healthcare providers; professionals such as engineers, scientists and analysts; IT professionals and other technology specialists; managers and executives, whose position cannot readily be replaced by machines; and educators and people in creative industries (artists, performers and entertainers).

Nesta (2015) states that in the US, 86 % of workers in the highly creative category are found to be at low or no risk of automation. In the UK, the equivalent number is 87 %. The study concludes that economies like the UK and US, where creative occupations make up a large part of the workforce, may be better placed than others to deal with the disruption of employment from future advances in automation. However, these assumptions take for granted that algorithms cannot produce creative content, which might not necessarily hold true[23].

21 https://www.theguardian.com/science/2018/apr/18/defeated-by-ikeas-flatpack-call-in-the-robots. Accessed on 20 March 2019.
22 https://www.hansonrobotics.com/sophia/.
23 https://www.technologyreview.com/s/609482/ai-is-dreaming-up-new-kinds-of-video-games/. Last accessed on 20 March 2019.

The World Economic Forum (2016) points out that another type of job for which demand is likely to grow is specialised sales representatives. Practically every industry will need to become skilled in putting to market and explaining their products to business or government customers and consumers, given the innovative technical nature of the new products.

Last but not least, an important point needs to be reiterated: just as computers created jobs within and beyond the computer industry, the current automation wave of digital transformation has started to do the same. For example, McKinsey (2017a) indicates that e-commerce (as already mentioned in Section 3.4.3) has supported the growth in related activities such as package delivery. This point is crucial for developing and managing the ensuing transitions appropriately.

3.2.4. Examples of new jobs

Moving one step further, from working out which existing jobs will grow in importance to figuring out which new jobs will be created, is an even harder. For example, McKinsey (2017b) suggests that several trends will influence future labour demand. These include caring for others in ageing societies; improving energy efficiency and addressing climate challenges; producing goods and services for the expanding consumer class (especially in developing countries); and investing in technology, infrastructure and buildings, which all countries need to do. These predictions are understandably vague. Historically, automation has caused growth in occupations due to demand and the creation of new types of occupations that did not exist before. McKinsey's study suggests that this job growth has the potential to offset the jobs lost to automation.

While it might not be possible to predict all the new jobs that will be created, some occupations stand out as obvious. One such example is a data scientist, a professional responsible for collecting, analysing and interpreting large amounts of data so as to identify ways to help a business improve operations and gain a competitive edge over rivals[24]. Data scientists are a new breed of analytical data experts who have the technical skills to solve complex problems – and the curiosity to explore what problems need to be solved. They are part mathematician, part computer scientist and part trend-spotter. They straddle the business and IT worlds, which makes them highly sought-after and well-paid[25]. Such data scientists can also play an important role in data cleaning, which will be increasingly important for AI development and uptake in companies, but also in helping address data biases and ensuring privacy. With the increasing uptake of AI technologies, it seems fairly certain that there will be a growing demand for data scientists.

Another example is provided by ethics officers, who are responsible for looking at every single aspect of an organisation's procedures to make sure that they are consistent with its

24 https://searchenterpriseai.techtarget.com/definition/data-scientist. Last accessed on 20 March 2019.
25 https://www.sas.com/en_be/insights/analytics/what-is-a-data-scientist.html. Last accessed on 20 March 2019.

code of ethics[26]. The development of AI technology raises many ethical issues, making it likely that ethics officers will play an increasingly important role within organisations.

3.2.5. Impact on specific groups

Looking at the projected impact of AI and robotisation on labour markets, it seems that these will affect certain social groups more than others, such as young people and women. This has important policy implications for Europe.

Demographic developments will cause the European labour force to shrink in the coming decades. The total labour supply in the EU is projected to fall by 9.6 % by 2070. There will be a larger reduction in the labour supply of men (-10.6 %) compared to women (-9.2 %)[27]. Bain (2018) points out that this could be good news for younger workers, whose market value could be boosted by the relative scarcity of labour.

At the same time, the OECD (2018a) finds that the risk of automation is highest among teenage jobs. The risk of automatability among youth jobs is higher than for older workers. From this point of view, it seems that automation is much more likely to result in youth unemployment than in early retirements. The reason for this pattern lies in young workers' occupational choices. According to the OECD study, around 20 % of those aged 20 or younger work in elementary occupations (as labourers, cleaners and helpers, and in agricultural jobs, food preparation and refuse jobs), while only 7 % of those older than 20 work in such jobs. Another 34 % of teen jobs are in sales and personal services, another occupational group with a relatively high risk of automation, while only 13 % of older workers hold such jobs. In the context of high youth unemployment in some EU Member States, such as Spain (33.5 % in Q4 2018) and Greece (40 % in Q4 2018), this finding is a particular cause for concern for European policymakers.

Women represent another social group that is likely to be affected disproportionately by increased uptake of AI. The World Economic Forum (2018) estimates that over 57 % of the workers who will be affected by labour market disruptions are likely to be women. One of the explanations is that women are more likely to be employed in jobs facing high risks of automation. For example, 97 % of cashiers are expected to lose their jobs due to automation in the next few years (see case study on Amazon Go). In 2016, 73 % of cashiers were women[28].

In addition, women are also under-represented in key growth areas such as jobs requiring STEM knowledge and skills. In fact, there are four times more men than women in Europe with ICT-related studies, and the number of women taking up such studies is on a

26 https://www.bestjobdescriptions.com/education/ethics-officer-job-description. Last accessed on 20 March 2019.
27 The 2018 Ageing Report. Underlying Assumptions & Projection Methodologies. European Commission Institutional Paper 065, November 2017
28 https://www.weforum.org/agenda/2017/07/why-women-are-twice-as-likely-as-men-to-lose-their-job-to-robots. Last accessed on 20 March 2019.

downward trend. The share of men working in the digital sector is over three times greater than women's share[29], which signifies a growing gender-related digital skills gap. The coming AI revolution will only increase the importance of ICT and STEM jobs, which will have a negative impact on female labour market participation, unless more women take up relevant educational degrees.

Another negative implication from the increased uptake of AI is the potential to reinforce algorithmic bias against women. Forbes pointed out that as of August 2018, about 85 % of the machine learning workforce was male[30]. Unless more balanced and diverse developer teams are actively encouraged, conscious or subconscious biases could sneak into algorithms, which will influence their output. Bearing in mind the increasingly important role that algorithmic decision-making is likely to play in society in the next few years, this is a cause for concern.

3.3. Impact on productivity and wages

A key component of understanding the impact of AI and robotisation on employment, wages and living standards is how these technologies will affect productivity growth. While the first two industrial revolutions caused productivity to grow, their impact was not uniform. During the first industrial revolution, the creation of the steam engine, railways and steamships, along with cotton spinning and weaving, caused hourly output to grow by 1.5 % a year on average between 1890 and 1920. The second industrial revolution (characterised by electricity, motor vehicles, the growth of information and communication technology, chemicals and changes in working conditions) resulted in a 2.8 % average annual growth rate of output per hour between 1920 and 1970.

The effect of the digital revolution on productivity, on the other hand, has been much weaker than expected (1.6 % between 1970 and 2014). Several factors seem to have made productivity growth lower than expected. The OECD, for example, has suggested that the global slowdown in productivity growth is caused by increasing productivity divergence between frontier and laggard firms. Companies at the global frontier continue to enjoy robust productivity growth, thereby increasing the gap with laggard firms. This tendency is at least partially explained by technological divergences resulting from the structural changes in the global economy, such as globalisation and digitalisation.

In fact, according to McKinsey, only about 20 % of firms are early adopters of technologies such as AI, and they are essentially in the tech, telecoms and financial sectors. This AI diffusion gap undoubtedly influences the lower-than-expected productivity growth. The vast majority of firms either conduct some pilot studies which are not followed up by operationalisation in day-to-day activities or do not consider using AI at all. In addition,

29 Women in the Digital Age (2018). Available at https://ec.europa.eu/digital-single-market/en/news/increase-gender-gap-digital-sector-study-women-digital-age. Last accessed 20 March 2019.
30 https://www.forbes.com/sites/cognitiveworld/2018/08/01/why-women-should-be-excited-about-ai/#52b8f4301272. Last accessed on 20 March 2019.

there is a correlation between the technological and other gaps, such as the size of companies - in particular, SMEs are laggards in taking up the new technologies, including AI (see also Section 5.2 on SMEs and the AI transformation in Europe). The AI diffusion gap is also large because the approach to implementing AI is often piecemeal, uncoordinated or lopsided. Successful firms, on the other hand, start by defining the objectives of using AI, then redesign workflows and make available a proper dataset, which is essential for AI to work. In essence, this means redesigning the organisation of the company (for more on this subject, see Section 2.3).

Another factor is that most consumer-based technological inventions have now reached a peak; for instance, if you have an iPhone 7, you will not buy an iPhone 8, X or XS, because the iPhone 7 is already very sophisticated. Most people will replace their phone only if it is broken. In addition, many of the innovations brought about by AI and robotisation are not yet ready for mass consumption - this can be seen with autonomous cars, for example. This results in productivity trends that are flatter than expected, which will pick up again only when AI products and services are ready for mass consumption. From this perspective, supporting AI development and take-up becomes paramount for policymakers.

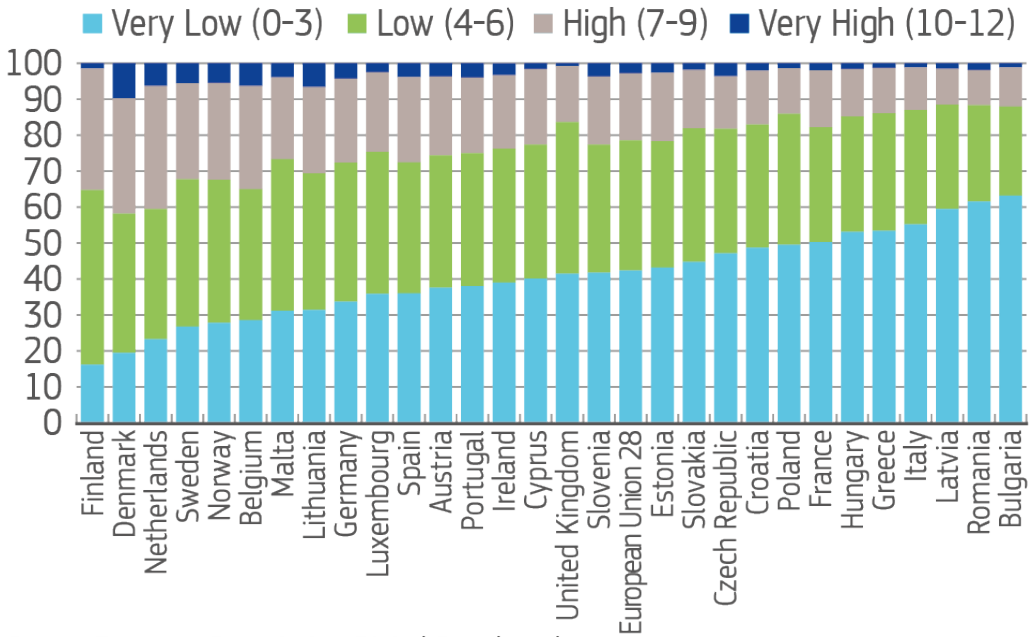
One issue to consider is that, while the productivity boom already started to wane in the 1990s, it was adversely affected by the impact of the financial crisis, in particular a weak demand, uncertainty and a massive reduction in productive investment during and after the crisis.

This has important implications for the current fourth industrial revolution, as AI and robotisation are expected to have a major impact on productivity, but this is not yet visible in productivity statistics.

Other factors appear to be the transition costs and the risks of revenue losses for incumbents, which slows down adoption of the new technologies. Most of the economy is not yet digitalised: McKinsey has calculated that Europe operates at only 12 % of digital potential, and the US at 18 %, with large industrial sectors lagging behind. While ICT, media, financial and professional services are rapidly adopting the new technologies, other sectors such as construction, healthcare and education are lagging behind. In addition, while the productivity of e-commerce is twice that of sales from physical shops, e-commerce is static at around 10 % of overall sales volumes. Overall, the dissemination of the new technologies seems to be substantially slower than with previous technologies, which dampens productivity improvements.

Only a fifth of companies in the EU-28 are highly digitalised, but the situation varies from one country to another while 40 % of companies in Denmark and the Netherlands are highly digitalised, the figure for Bulgaria and Romania is 10 % (see Graph 8).

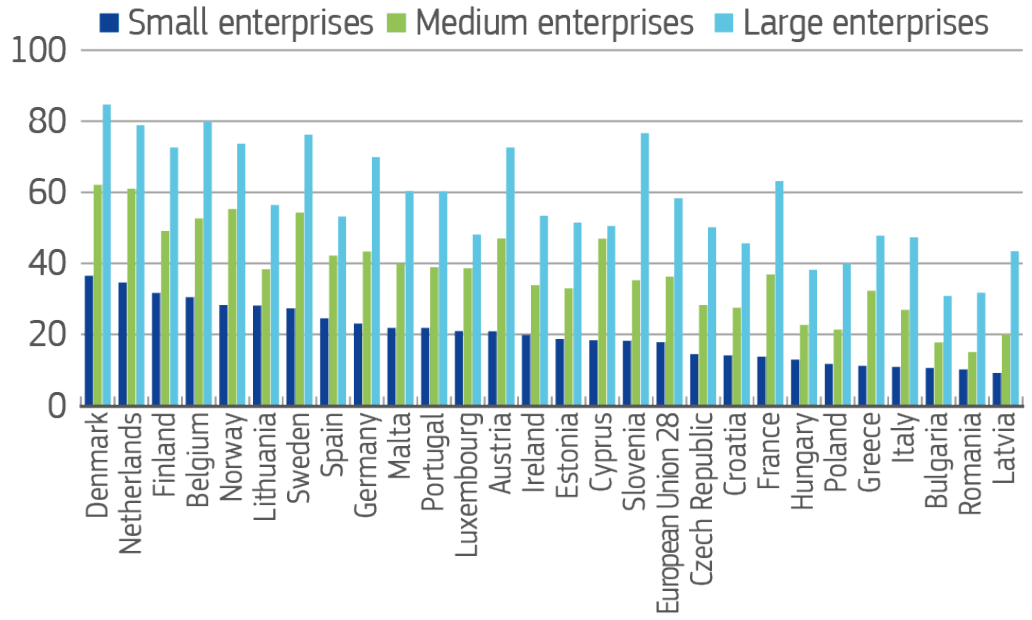
Graph 8: Digital Intensity score for Enterprises



Source: European Commission, Digital Scoreboard

Graph 9: Enterprises with High levels of Digital Intensity by size of enterprise in 2017, without financial sector

Percentage of enterprises



Source: Eurostat - Community survey on ICT usage and eCommerce in Enterprises

In addition, transition costs for companies can be substantial. In a recent study of companies undertaking digital transformations, McKinsey showed that 17 % of their market share was taken by their own digital products or services. In other words, companies are allocating substantial resources and investments to digitalisation with no immediate impact on productivity or growth. Moreover, the dissemination of the new technologies is uneven: some companies, which deliberately choose to defer the adoption of new technology, can benefit from lower costs and more competitiveness by opting out (see Graph 9).

Productivity growth is also limited by the availability of digital infrastructure. This is why Member States' investment in digital infrastructure and other enabling factors is paramount. Countries vary in this respect: some, such as the Netherlands, have been investing heavily in digital infrastructure, while others, such as Italy, have neglected the issue. Investments in this area are important from a regional perspective as well, as existing regional divides are only likely to be exacerbated by automation and the increased uptake of AI, unless the infrastructure gap is addressed. For example, one of the focuses of China's push to AI supremacy is to address rural and regional development gaps – in fields such as healthcare or education, where large disparities between major cities and the rest of the country are observed.

The impact of AI on productivity is extremely important because of how it affects labour markets (see Graph 10). Strong productivity growth means better wages and the promise of quality jobs. History suggests that technological developments bring higher productivity and better living standards in the long run. However, McKinsey (2017b) points out that this transition has not always been very smooth. During the industrial revolution in 19th century England, real wages stagnated for almost 50 years and only started to rise again thanks to substantial social policy reforms.

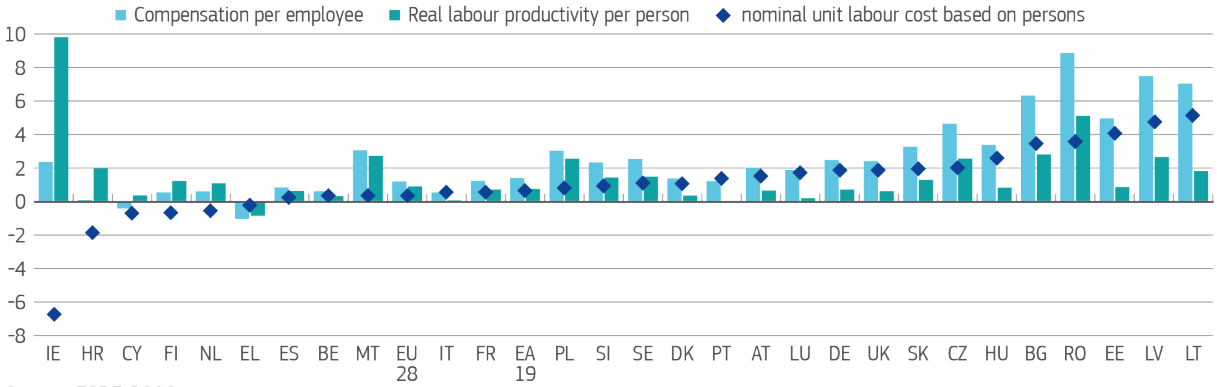
Wages will be under pressure for some categories of workers, especially those who have not attended university, depending on sector and country. McKinsey (2017a) further estimates that in advanced economies, a polarisation of wages that has particularly affected middle-wage jobs is likely to continue.

The impact on wages of the spread of AI in the economy is hard to predict, as it will depend on many factors. As already discussed, the main one of these is the extent to which AI boosts productivity growth. Another important factor concerns how the impact of AI affects workers with different levels of skills. One of the most negative wage development scenarios includes overall productivity growth continuing to stagnate while AI affects mostly low- and medium-skilled jobs. While it is harder to predict the productivity variable in this equation, the existing evidence suggests that the second part of the equation (impact on skill levels) is quite likely to hold true. Such a scenario leads to lower wages for the low-skilled and further labour market polarisation. Indeed, it seems that automation is

likely to benefit highly skilled workers more, as they will be better placed to adapt to technological changes in the workplace. This means that automation has the potential to exacerbate income inequality significantly. The impact on inequality is discussed further in Section 6.5.

Graph 10: Unit labour costs continue their restrained upward trend in most Member States

Growth in nominal unit labour cost, nominal compensation per employee and real labour productivity (% compound growth 2014-2017), EU, Euro area and Member States

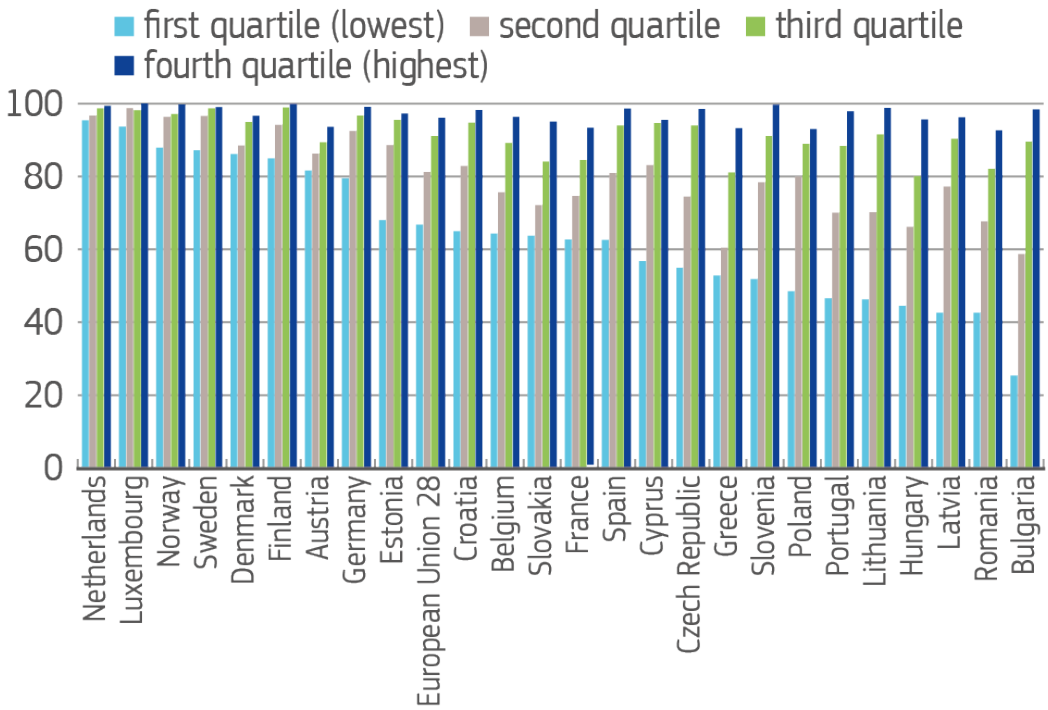


Source: ESDE 2018

In a more optimistic scenario, the spread of AI could also lead to better jobs and higher overall wages. It is possible that increases in productivity and stronger demand for high-end products, coming from the growing uptake of AI and automation, could lead to strong overall job and economic growth in Europe. To make certain we achieve this, however, Europe needs to ensure that the benefits of AI are shared across all groups in society and that the technology is open, accessible to all and understandable (see Graph 11).

For this to happen, governments would need to prioritise all measures that support the wide dissemination of new technologies and reduce transition costs. The following chapters focus on some of these measures. They include, but are not limited to: stepping up public investment in new technologies, in particular digital infrastructure and connectivity; leveraging public procurement to that effect; driving adoption of digitalisation and AI by SMEs; supporting workers' training and transition programmes on a huge scale; and leading education systems to a major shift towards the AI era.

Graph 11: Percentage of households with a broadband connection in 2017, by income quartiles



Source: European Commission, Digital Scoreboard

3.4. Impact of AI on growth and job creation

Having examined different interlocking aspects of the issue in previous sections, we now come to the central question of this report: what will be the overall impact of AI on growth and job creation? This depends on many factors. How AI and robotisation influence labour markets is contingent, for example, on the speed of uptake of new technologies. Bain (2018) points out that if automation is more gradual, workers who lose their jobs will have more time to adjust, retrain or simply retire from the workforce. More importantly, the same study also estimates that rapid automation in the US service sector could displace labour twice or three times more quickly than in previous economic transformations. This finding is important for European labour markets, with 73.9 % of people working in services in 2017[31].

The net effect of automation on job creation will also be influenced by the pace at which displaced workers can be retrained and migrate towards higher-skilled jobs. This has important implications for public policy. As suggested by McKinsey (2017b), more investment and productivity growth because of automation might spur enough growth to ensure full employment, but only if the majority of displaced workers find new work relatively quickly, within a year. Being out of a job for more than a year can significantly

31 Eurostat, nama_10_a10_e

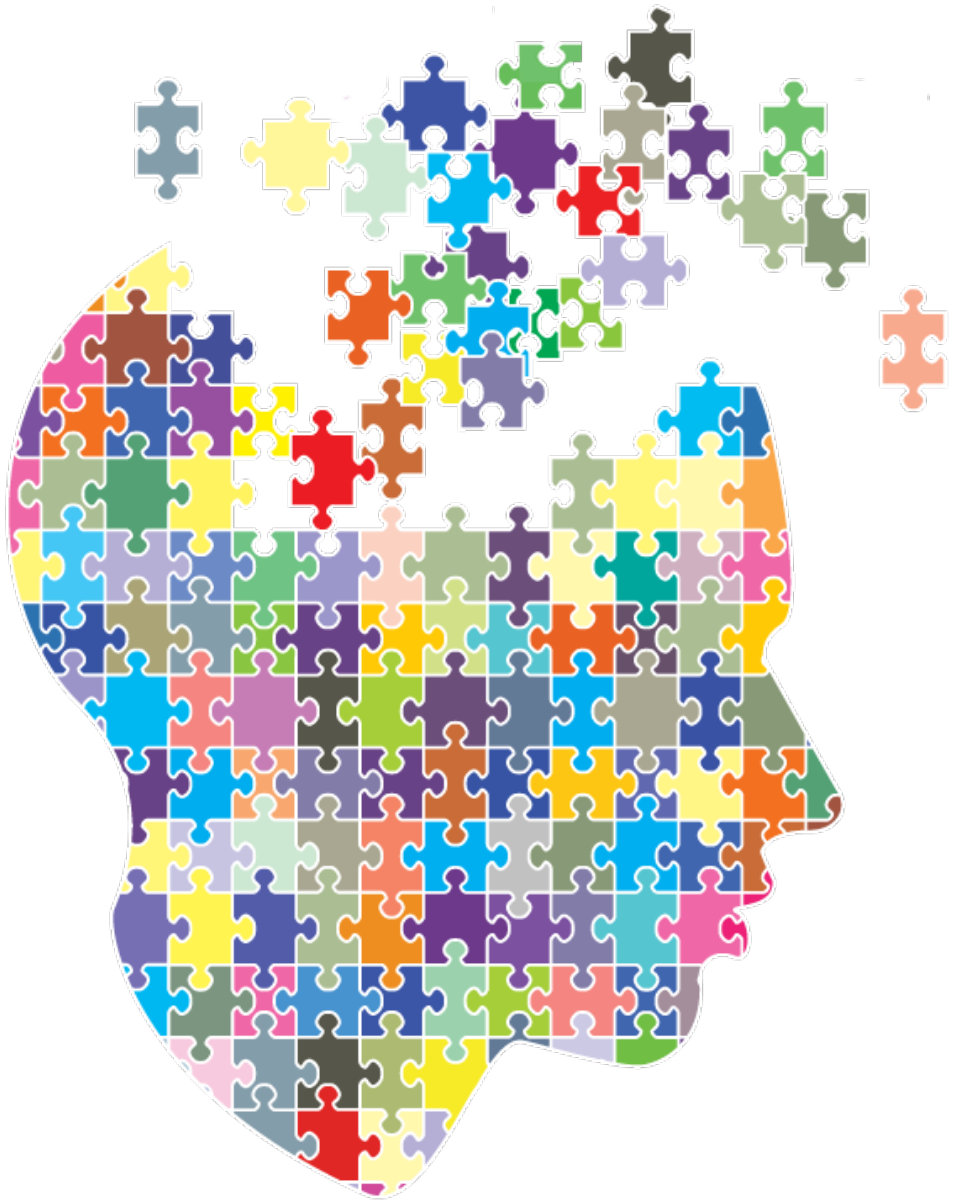
impair one's ability to find a job later on, which makes it all the more important to manage labour market transitions caused by AI and automation.

It is not clear whether the impact of current automation on labour market participation will be significantly different from previous periods of automation or not. Some jobs will be lost through automation, but this will not necessarily lead to widespread technologically induced unemployment. What is clearer is that adjustment to this process will be complicated by the fact that new jobs will require significantly higher levels of skills.

So, what will be the net result when we draw the line? Will there be more or fewer jobs? Probably more, but the truth is that we do not know how many more, in which sectors they will emerge, or when they will become available. After looking at the present evidence and emerging trends, this report concludes that one factor will be crucial for ensuring that the overall impact of AI and robotisation on the future of labour in Europe is a positive one. This is successfully managing the resultant labour market and societal transitions - the subject of the next chapter.

CHAPTER 4

LABOUR MARKET TRANSFORMATIONS AND EDUCATION



The chapter at a glance

Have you ever wondered what all the fuss about the impact of AI on labour markets is about? Sure, some jobs will be lost, but it seems certain many new jobs will be created as well. Why don't people who lose their jobs to a robot just switch to another job?

Worker transitions, adaptation and skills requirements will be significant challenges to adapt to the coming age of AI. Complex transitions will be unavoidable, as the places and sectors where new jobs will emerge will not be the same as the old ones being lost. We cannot predict which new jobs will appear, but this does not matter, as the most important thing is to have the skills necessary to take on different types of new activities - activities we know nothing about now.

This chapter examines the impact that the current wave of automation will have on education systems. It finds that they are currently not well equipped to reflect the needs of the future and prepare students for life with AI and for a labour market whose needs may well be unpredictable. Constructing 'future-ready' curricula includes reviewing core linguistic, mathematical and technological literacies and ensuring that enough attention is given to building digital literacy. An additional weakness across most education systems today remains the ecosystem for lifelong learning. Lifelong learning systems are geared to high-skilled workers, while participation remains significantly lower among workers in jobs at risk of being automated.

Automation affects education systems but also the nature of work. New ways of working emerge on digital platforms and the collaborative economy, with more part-time and freelance work and more self-employment. For an ever-increasing number of workers, this replaces the traditional employer-employee relationship. The result is more flexibility, or improved work-life balance, and of course, supplementary income. However, there are also some challenges. The present chapter examines all these aspects.

The potential for economic growth offered by artificial intelligence and robotisation is enormous, but worker transitions, adaptation and skills requirements will pose significant challenges. Complex transitions will be unavoidable, as the places and sectors where new jobs emerge will not be the same as the old ones being lost. McKinsey (2017b) estimates that by 2030, 75 million to 375 million workers (3 to 14 % of the global workforce) will need to switch occupational categories.

This report takes the view that is hardly possible to predict the new jobs that will appear; but it does not matter, as the main thing is to have the skills necessary to take on different type of new activities - activities we know nothing about now. To manage the transitions brought about by automation and AI, education systems will therefore play a paramount role. The way learning is organised at present (preparing people for specific jobs, such as being carpenters, rather than focusing on transversal skills) fails to address the societal changes being brought about by the new wave of technologies.

Adult education is currently very time-limited and focused on young people, as opposed to a more continuous education experience for adults. The current system for certification of

skills fails to take account of recent developments, such as the increased availability and use of massive open online courses (MOOCs). Recognition of informal skills is largely lacking, while qualification systems lack a sufficient level of granularity to make them more flexible. Addressing all of these issues would enable us to cope better with technological changes in the labour market.

As new technologies continue to shape and change skills demand at an ever-growing speed, the scope for more personalised provision of skills increases. Accenture (2018a) points out the example of Skillshare, which is a US-based online learning community that connects individuals with expertise in dozens of creative and entrepreneurial disciplines with others who wish to learn from them. Today, the Skillshare community consists of over 5 million members, 6 000 of whom are teachers, delivering courses from 100+ countries around the world. In addition to taking classes, members can also use the site to receive feedback on projects, connect with others in their industry, and discover new career opportunities.

Case study: Blockchain as a way to certify and accredit skills

Blockchain is an emerging technology, with almost daily announcements about its applicability to everyday life. It is seen as providing significant opportunities to disrupt traditional products and services thanks to the distributed, decentralised nature of blockchains and to features such as the permanence of the blockchain record, and the ability to run smart contracts. It is forecast to disrupt any field of activity that is founded on time-stamped record-keeping of titles of ownership.

Within education, blockchain technology may accelerate the end of a paper-based system for certificates. Any kind of certificates issued by educational organisations, in particular qualifications and records of achievement, can be permanently and reliably secured using blockchain technology. More advanced blockchain implementations could also be used to automate the award, recognition and transfer of credits, or even to store and verify a complete record of formal and non-formal achievements throughout lifelong learning.

Blockchain technology enables users to verify the validity of certificates automatically and directly against the blockchain, without the need to contact the organisation that originally issued them. Thus, it can obviate the need for educational organisations to validate credentials.

This ability to issue and then reliably validate certificates automatically can also be applied to other educational scenarios. Thus, one can imagine certificates of accreditation being issued to institutions by quality assurance bodies, or licences to teach being issued to educators, with all of these being publicly available and verifiable by any user against a blockchain.

The technology can also be applied to intellectual property management, to track first publication and citations, without the need for a central authority to manage

these databases. This makes it possible, for instance, to automatically track the use and reuse of open educational resources.

Source: European Commission's Joint Research Centre: Grech, A. and Camilleri, A. F. (2017) Blockchain in Education. Inamorato dos Santos, A. (ed.) EUR 28778 EN

4.1. Managing education systems

McKinsey (2017b) points out that unlike earlier transitions, when young people left farms and moved to cities for industrial jobs, the challenge brought about by automation will be to retrain mid-career workers. There are few examples of societies successfully retraining so many people.

Skills anticipation is a very important piece of the puzzle, as artificial intelligence and robotisation are reshaping not just work itself, but also the skills needed for work. In addition, the pace of change is increasing, which further aggravates ongoing skills disruptions. Some of the current skills readjustment is happening outside schools and jobs. Education is increasingly central to the changing nature of work.

Skills mismatches may emerge not just between the supply of and demand for existing skills today, but also between today's skills base and future skills needs. The World Economic Forum (2016) suggests that efforts to close the skills gap will increasingly need to be grounded in a sound understanding of a country's or industry's skills base today and of changing future skills requirements stemming from disruptive change. For example, efforts to place unemployed young people in apprenticeships in certain job categories through targeted skills training may be self-defeating if skills requirements in that job category are likely to be drastically different in just a few years' time.

The rapid development of AI technologies presents a challenge to successful skills forecasting, but also an opportunity. Machine-learning-powered AI techniques are very good at spotting patterns from large amounts of data, which could potentially be used to help forecast the skills of the future. LinkedIn's Economic Graph is a case in point. It is a digital representation of the global economy based on all the data in LinkedIn - 560 million members, 50 thousand skills, 20 million companies, 15 million open jobs and 60 thousand schools. By mapping every member, company, job and school, it spots trends like talent migration, hiring rates and in-demand skills by region. These insights can help to connect people to economic opportunity in new ways.

Case study: The Skills Bank in Sheffield, UK

The Skills Bank is a service that invests in skills and expertise to drive business growth. It supports employers in the Sheffield City Region, helping them invest in

the skills that their staff need for their business to develop and grow. Advisors work with businesses to identify the skills needed, to apply for funding where appropriate, and to connect with high-quality training providers.

The £17 million fund comprises funding from the European Social Fund and the UK Government's Growth Funding. The Skills Bank can provide funding of up to 70 % of the cost of training staff to gain new skills or refresh existing capabilities.

Source: http://www.sheffcol.ac.uk/employers/skills-bank

However, given the rapid changes and potential for disruption stemming from AI, skills anticipation will not be enough to prepare the labour force for future labour markets. We will also need to focus on providing students with a broad general foundation comprising a mix of basic, soft and digital skills. The next section explores this issue further.

4.1.1. Are education systems fit to prepare young people for important and regular career transitions?

Education systems are currently not sufficiently equipped to reflect the needs of the future and prepare students for life with AI and for a labour market whose needs may well be unpredictable. Education in this context is important to improve technological understanding and enable people to navigate an increasingly digital world. This can also inform the debate about how AI should (or should not) be used. Constructing 'future-ready' curricula includes reviewing core linguistic, mathematical and technological literacies and ensuring sufficient attention is given to building digital literacy. Important components of any curriculum reform and programme design include ensuring the availability of high-quality teaching and appropriate funding infrastructure, motivating learners effectively and including all relevant public- and private-sector stakeholders in an appropriate way.

Students need to be adequately prepared for working with and using AI. This will mean a thorough education in AI-related subjects and support for teachers. For all students, the basic knowledge and understanding necessary to navigate an AI-driven world will be essential. The House of Lords (2018) report on AI points out that these aspects will need to be integrated from early on in the school curricula. Crucially, the integration of computing into the school curriculum must not come at the expense of arts and humanities, which hone the creative, contextual and analytical skills that will probably become more, not less, important in a world shaped by AI.

The House of Lords (2018) report also suggests that when looking at the relevance of education, it seems that the more distant a person is from the subjects of science, technology, engineering and mathematics, the less likely s/he is to appreciate the changes that are under way concerning AI. A point not to be underestimated by policymakers is that we need to make sure AI technology is developed in a way that makes it open, accessible

and understandable to all. While there are various aspects to this, making the education system AI-proof is central to successfully adapting to technological change.

Artificial Intelligence can be used to tackle some of the pressing challenges facing existing education systems, such as improving social inclusion and fairness or addressing the dichotomy between the uniformity of skills and personal development promoted in curricula and the increased need for individuality sought by employers when hiring. If used properly and equitably, AI can help usher in a revolution by providing a more individualised education, taking account of the strengths and weaknesses of each student, tailoring and personalising learning, lessening the burden on teachers and adapting to technological change. To achieve this, however, some of the inherent flaws in existing AI technology would have to be addressed.

The need for more personalised education also applies to higher education. Examples of good practices already exist. The Swiss Federal Institute of Technology in Zurich (ETHZ) offers a programme of customised continuing education focusing on advanced materials, process and manufacturing technologies[32]. Participants' expertise and skills are promoted and expanded in a targeted way, using a research-oriented approach that takes full account of their interests and needs. Participants design personalised study plans in cooperation with a mentor. Within the scope of their personalised study plan, they can take part in research projects, deepen and supplement their technical knowledge through courses, or share their expertise in seminars. The customised ETHZ programme gives experienced professionals from technical industries an opportunity to deepen their expertise and extend their skills in their field of expertise in the broader area of advanced materials and processes. The programme builds on the expertise of its participants and is designed to focus on a particular area that is specific for each individual. Current advances in AI technologies could be used to scale up such an approach to secondary schools as well and over a variety of educational programmes.

Case Study: MIT announces USD 1 billion AI college

On 15 October 2018, MIT announced a new USD 1 billion commitment to addressing the global opportunities and challenges presented by the prevalence of computing and the rise of artificial intelligence. The initiative marks the single largest investment in computing and AI by an American academic institution, and will help position the United States to lead the world in preparing for the rapid evolution of computing and AI.

Headquartered in a new building on MIT's campus, the new MIT Schwarzman College of Computing will be an interdisciplinary hub for work in computer science, AI, data science and related fields. The College will:

[32] https://www.ethz.ch/content/associates/continuing-education/en/programme-und-kurse/suche-angebote.html?polycourseId=1583. Last accessed on 20 March 2019.

- reorient MIT to bring the power of computing and AI to all fields of study at MIT, allowing the future of computing and AI to be shaped by insights from all other disciplines;
- create 50 new faculty positions that will be located both within the College and jointly with other departments across MIT — nearly doubling MIT's academic capability in computing and AI;
- give MIT's five schools a shared structure for collaborative education, research, and innovation in computing and AI;
- educate students in every discipline to responsibly use and develop AI and computing technologies to help make a better world; and
- transform education and research in public policy and ethical considerations relevant to computing and AI.

With the founding of the MIT Schwarzman College of Computing, MIT seeks to strengthen its position as a key international player in the responsible and ethical evolution of technologies that are poised to fundamentally transform society.

Source: http://news.mit.edu/2018/mit-reshapes-itself-stephen-schwarzman-college-of-computing-1015

In a labour market increasingly shaped by automation, soft skills will play a more prominent role, as the level of AI development cannot yet match humans in these skills. Soft skills refer to the interpersonal characteristics that enable a person to interact effectively with others. Such skills include communication, teamwork and problem solving. They relate much more to attitude and intuition than acquiring knowledge, and as such, are much more difficult for an algorithm to internalise. A major shortcoming of existing education systems is that they are not good at fostering these skills, which are acquired and honed at work much more often than at school. This is problematic, given the increasingly important role such skills are likely to play in future job markets.

Another important set of skills for the age of AI are general cognitive skills. Despite advances in the field, AI cannot yet outperform human thinking, given the subjective, highly individual and ever-changing nature of most scenarios likely to occur in real life (and at work). General cognitive skills have an impact on how a person understands the world and acts in it. They have more to do with how we learn, remember, solve problems and pay attention, rather than with any actual knowledge. As such, they are not well covered by existing educational curricula, which still tend to focus more on rote learning than on promoting critical thinking.

Another flaw in Europe's educational ecosystem today is its relative lack of interplay and collaboration between general and technical educational pathways (with some notable exceptions, such as Germany and Switzerland). At present, bridges between general and VET education are largely lacking. The current mindset is that students go to either general

or VET education throughout their academic careers, without necessarily considering taking part in both, or switching from one to the other at some point. As a result, general schools equip students with general skills, but not technical skills, while the reverse applies to VET establishments. By contrast, a more synergetic educational framework would allow the creation of individualised learning pathways, which could enable students to learn what they need and to benefit from the right learning approach for them. In turn, this would allow them to better adapt to a labour market shaped by artificial intelligence and automation.

Australia's Technical and Further Education (TAFE) institutes are good examples in this regard. They are government-owned providers of VET courses, which can lead to different types of qualifications. The student pathways are not limited to VET, as they also give access to general higher education by providing credits towards some higher education courses. The TAFE sector is the biggest education and training sector in Australia[33].

Labour market demand is constantly evolving, driven by technological developments, among other factors. If not reformed, educational institutions could find it increasingly harder to adapt to this evolution and make sure that vital job skills are being taught. This increases the risk of an ever-widening gap between education and employment.

Organised intelligently, apprenticeship schemes can offer a way of addressing this gap. However, there are still some hurdles to a larger-scale adoption of apprenticeships and vocational training schemes. These include the stigma associated with them, as they are still perceived as being a second-rate track by comparison with university. The public still seems to be unaware that apprenticeship opportunities also exist in higher-tech future-oriented industries, such as banking, IT, human resources and healthcare. Cost and complexity are also an issue, as regulating apprenticeships can be a cumbersome process in many countries.

Accenture (2018a) mentions another interesting example of bridging the labour demand and supply gap. The Markle Foundation, a US-based non-profit organisation, has developed Skillful: an initiative to help American workers and employers adapt to the digital economy. Skillful facilitates transparency about the value of educational and training programmes and fosters the adoption of skills-based talent management practices to give educators a clearer picture of which skills are in demand in their area, businesses a better way of recruiting and assessing applicants, and job seekers a better understanding of potential career pathways. Since its launch in Colorado, nearly 600 businesses have been trained in skills-based hiring practices and more than 200 career coaches have joined an online community to learn from Skillful and each other. Skillful recently expanded with the creation of the Skillful State Network, a collaborative group of 20 governors from both major political parties, to transform the US labour market to one that is skills-based.

33 https://www.studiesinaustralia.com/studying-in-australia/what-to-study-in-australia/types-of-education/technical-and-further-education. Last accessed on 20 March 2019.

Case study: Vocational education and training in Switzerland

The Swiss VET system is fully embedded in and linked to the country's overall education system. At the age of 15 or 16, young people decide what to do for their post-compulsory education. Essentially, they choose between general education and VET. Two further options exist within each pathway: the academic baccalaureate and special baccalaureate in general education, and the two-year certificate or three-to-four-year Federal VET Diploma within VET. Thanks to Switzerland's nationally recognised credentials for all programmes, graduates can be sure that VET diplomas will have currency with future employers or further education institutions.

The transition from compulsory schooling is very demanding, especially for students who choose the VET pathway and have a choice between 230 occupations. The transition confronts young people with a real labour market — in this case the apprenticeship market — for the first time, and they have to cope with the realities of supply and demand. Participants apply and each hopes to be accepted into their favourite occupation and company, but they usually make multiple applications. The VET pathway is the most popular choice and a critical part of the country's education system, with 70 % of young people choosing VET in every cohort.

Independent career guidance and counselling centres provide information on the many programmes available and offer guidance to adolescents so they can make informed decisions and succeed in the apprenticeship market. Further support measures ensure that as many young people as possible have access to upper-secondary education. This includes selection guidance, application help, bridge courses, and case management to give every student the best chance, while supporting those at risk of dropping out of school.

Very importantly, the Swiss VET system's permeability enables young people to make up for less than ideal choices and changing preferences by providing progression routes among every education level and type. For example, the Federal VET Diploma can be combined with the Federal Vocational Baccalaureate for strong students who want to continue their education at a university of applied sciences. With the addition of the university aptitude test, the student can progress into a conventional university.

Equipped with an upper-secondary education, young people in all programmes and pathways have a variety of further opportunities to progress in education or in the labour market. VET graduates have two 'tickets' at the end of their apprenticeships. The first enables them to enter the labour market directly, and likely succeed, thanks to the work experience earned through apprenticeship. The second lets them pursue further education with clear entry conditions for each. This strategy of permeability is the Swiss way of combining college and career readiness over a lifespan and avoiding early tracking.
Source: Accenture. Jobs Now – Swiss-Style Vocational Education and Training.

4.1.2. The importance of mid-career education

During previous industrial revolutions, it has often taken decades to build the training systems and labour market institutions needed to develop major new skill sets on a large scale. The World Economic Forum (2016) points out that given the upcoming pace and scale of disruption brought about by the fourth industrial revolution, however, this may simply not be an option. For example, current technological trends are bringing about an unprecedented rate of change in the core curriculum content of many academic fields, with nearly 50 % of subject knowledge acquired during the first year of a four-year technical degree outdated by the time students graduate, according to one popular estimate.

Additionally, a core weakness across most education systems today remains the ecosystem for lifelong learning. WEF (2017) suggests that innovation in this area depends on embracing openness to different educational routes – for example, expanding the availability of technical and vocational education and training (TVET), ensuring higher education remains affordable and appropriate, and expanding the lifelong learning opportunities available at and beyond the workplace. Current education systems are also time-centred in a way not very suited to current and future labour markets. They force from a very young age students in narrow career and expertise decisions. The divide between education systems and labour markets has to be overcome. Learning, (re)training, knowledge sharing, R&D and innovation should take place simultaneously throughout the work life cycle, no matter the job, level or industry. Moreover, adult education does not take sufficient account of adults who learn differently: this means shorter sessions, made simpler, with more repetitions and reminders.

Indeed, traditional forms of adult education might not be sufficient to deal with technological disruption, even if scaled up. Accenture (2018b) points out that they are often not fit for purpose and based on the passive transmission of knowledge. Traditional teaching methods are not sufficiently engaging for learning to 'stick' in adult brains and are not suited to developing the range of human skills, which will become even more important with technological change. These innately human skills include socio-emotional intelligence, complex reasoning, creativity and sensory perception skills. As Accenture (2018b) highlights, there is a need for experiential learning instead of classroom training. Such an approach includes using new technologies, such as virtual and augmented reality, on-the-job training and apprenticeships.

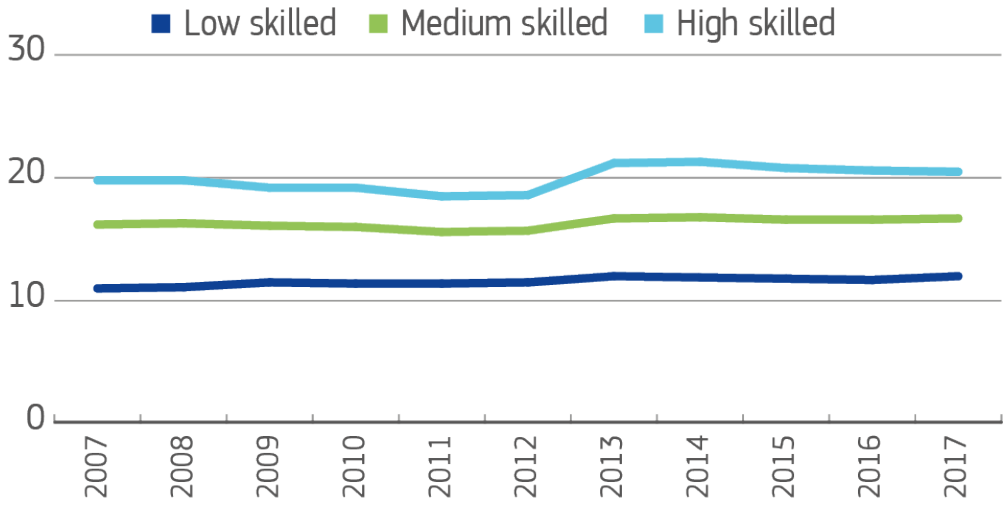
There is also a need to go beyond the current focus on a single institution (such as one's alma mater) providing lifelong learning opportunities. For example, coalitions of different schools could work together to provide lifelong learning, depending on their expertise in different fields/courses. This could be extended to higher education by creating regional coalitions, for example. The current higher education system is organised as a conventional end-point for acquiring knowledge, in which students attend an institution for several

consecutive years before graduating and starting work. This approach is problematic when it comes to acquiring and updating one's skills at key junctures in one's career. Some concepts have been developed to overcome this. One example is Stanford's 'open loop university' concept, developed as part of an exercise in imagining how the university could change by 2025. In the open loop system, students could start university whenever they feel ready (be it at 18 or 24). They would have a total of six years' education over a lifetime, to be used whenever and however they think most useful. Students could start their studies, then leave university after two years to join a company, then come back in their thirties, forties or fifties, for example. Experienced adults would thus be able to pivot careers and reconnect with the university community. These experienced adults would come back not only to enrich their skills, but also to teach about their experience and thus help bring university studies more into line with labour market demand. Knowledge could thus be obtained across classrooms and practical settings.

Looking at the relevance of lifelong learning systems, the OECD (2018a) finds that the odds of participating in any type of training, whether at work or externally, are significantly lower among workers in jobs at risk of being automated (see Graph 12). Workers in fully automatable jobs are more than three times less likely to have participated in in-service training, in the course of a given 12-month period than those in non-automatable jobs. Differences in training outside work are also striking: workers at most risk of automation are about twice less likely to participate in formal education and 3.5 times less likely to take part in distance learning. Moreover, individuals in fully automatable jobs are found to spend 29 hours less in job-related training annually than those in non-automatable jobs, all other things being equal. This underlines the importance of training provision outside the workplace, particularly for workers most at risk of automation.

Graph 12: Lifelong learning is not picking up

Participation rate in education and training (last 4 weeks), % of population 18-64 by educational attainment level, EU



Source: ESDE 2018

At present, when they provide lifelong learning opportunities, companies overwhelmingly focus on training their employees for current tasks. With the exception of a very small minority, employers are not preparing their companies or their employees for an economy shaped by AI (see more in Section 5.2 about the impact of AI on SMEs). Such an approach does not address changes in skills needs and is neither future- nor AI-proof. Most VET and lifelong learning programmes are designed for large companies and are not tailored to the needs of small firms. Moreover, some of the skills necessary for day-to-day work are provided only by the company that recruits the worker. Companies thus need to adapt to a broader role and to function as semi-educational institutions as the AI revolution in the economy unfolds.

New technologies can help companies fulfil this role. Accenture (2018a) mentions that in 2013, US telecommunications giant AT&T predicted that 40 % of their jobs would not exist in 10 years, so they embarked on a company-wide reskilling effort, dubbed 'Workforce 2020', to retain rather than hire talent as technology advanced. As part of this process, the company streamlined their organisational structure and created an online system, Career Intelligence, to help employees consider and navigate towards new internal career prospects. Today, more than half of AT&T's employees have completed a cumulative 2.7 million online courses in areas such as data science, cybersecurity, Agile project management and computer science.

Indeed, as Accenture (2018a) point out, successfully addressing technological transformations would mean building upon the skills that workers have already learned, rather than discrediting or discounting them. This would in effect mean focusing on 'new skilling' rather than only on 'reskilling', thereby providing workers with new skills to

supplement their existing expertise. In the example above, Accenture found that AT&T employees engaged in new skilling are twice as likely to be hired into a newer, mission-critical job within the company and four times more likely to make a career advancement.

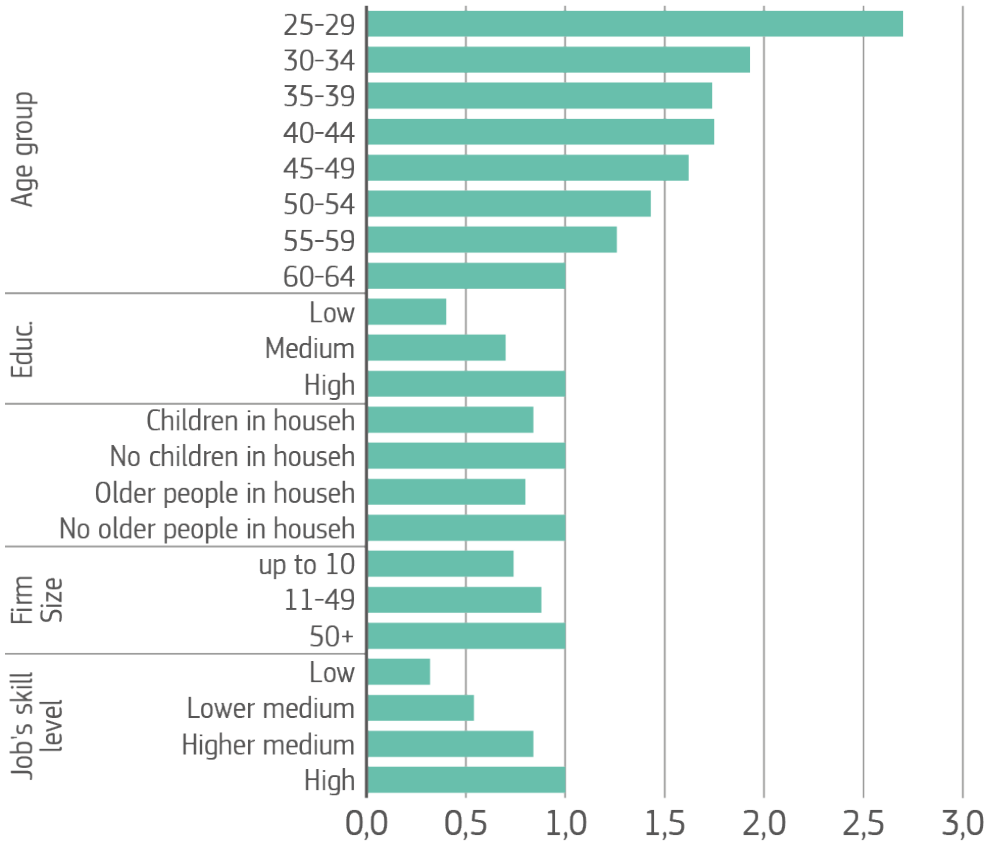
Another challenge in the lifelong learning ecosystem is the role played by public employment services. At present, PES are limited to helping workers gain new skills and get back to work once they have become unemployed. This reactive approach means that action to support workers' skills is taken too late, so that managing the ensuing transitions entails significant financial costs. By contrast, working to prepare for transitions together with companies and workers in employment could cost significantly less. If used properly and responsibly, AI could help PES counsellors provide their customers with more personalised services. It could also enable companies to help struggling employees more effectively, though the ethical repercussions would need to be carefully examined (see the case study on workforce analytics).

Accenture (2018a) highlights a good example of personalising employment services. Bayes Impact, a French start-up, has created Bob Emploi, a digital service using algorithms based on data from the French Employment Agency, to help job seekers find resources that best match their specific profiles. The services assess a jobseeker's individual situation before providing personalised recommendations on viable employment strategies. Within its first year, Bob Emploi had reached 130 000 users, 42 % of whom say the platform contributed to their finding a job.

Looking to the future, it seems certain that more job transitions will happen and that jobs will be more unstable. Linear career paths are becoming a thing of the past. The old model of one job for life no longer exists. We now see multiple transitions; workers regularly need to retrain and reskill for new developments (see Graph 13). This trend will increase in the future. Not only will workers face several job changes, but entire career transitions too. Acquiring new skills to keep up will be a must. Even now, OECD studies show that around 10 % of jobs may disappear as a result of automation, while another 35 % may be radically transformed. There is a danger of people being not only unemployed, but actually unemployable! The OECD (2018a) also finds that in the absence of regional requalification opportunities, the skills gap between obsolete routinised occupations and the growing non-routine ones may discourage workers from searching for jobs. Thus, unless retraining opportunities are made available to address technologically induced labour market changes, increased inactivity could be the outcome.

Graph 13: Workers' recourse to training depends on many factors

Odds of recently having attended lifelong learning, 2016



Source: ESDE 2018

Looking at the magnitude of the retraining challenge and existing inefficiencies in adult education, two problems stand out – the inadequacy of financing for vocational training and the fact that training is not targeted on those most in need. There is no funding structure to address these specific issues. However, some Member States have already started thinking about how to tackle these shortcomings. For example, France Strategie has recently proposed the introduction of a new European lending system to finance vocational training, targeting four types of people: (i) the unemployed and young people with no higher education, (ii) students already enrolled in higher education who wish to do an additional year of study, (iii) the employed and self-employed who want to retrain, and (iv) refugees. The fund that would be created to support this scheme would borrow on the financial markets and lend money directly to eligible citizens. Training programmes would target occupations that face manpower shortages and specific skills for which companies have a high demand[34].

The shortcomings of adult education also reflect problems in secondary education systems. Underachievement in basic skills among 15-year olds in Europe remains unacceptably high.

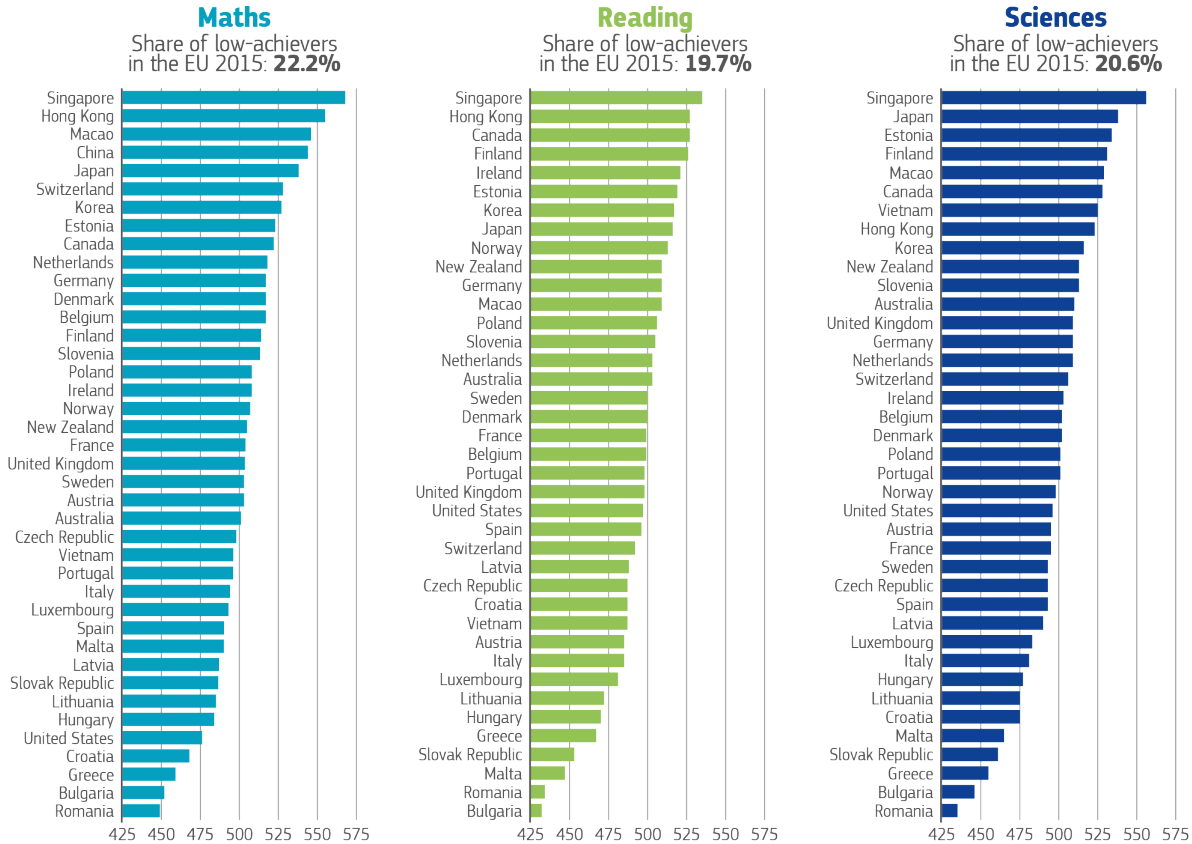
34 http://www.strategie.gouv.fr/english-articles/spinelli-fund-european-compact-skills-0. Last accessed on 20 March 2019

According to PISA 2015, 20.6 % of pupils underachieved in science, 19.7 % in reading and 22.2 % in mathematics, and these percentages are actually higher than in the previous testing period (see Graph 14). This is an additional cause for concern in the age of AI, as low achievers cannot successfully complete basic tasks that are required in modern societies.

The problem with inadequate basic skills is not limited to school students. Looking at the figures, there is a pressing need to support adults with inadequate basic skills as well. In the European Union, we have 61 million such people — as many as the population of a large Member State! For people with poor literacy and numeracy, let alone digital skills, finding a job in the new economy, and keeping it might be an impossible task.

Graph 14: Many young people lag behind their Asian peers

PISA scores in different disciplines, 2015, by country



Source: ESDE 2018

An inspiring example of what governments can do in the face of large-scale challenges is the US government's GI Bill, which enabled around eight million World War II veterans to go to college or be retrained.

Box 3. The GI Bill dramatically raised the educational attainment of American workers

The GI Bill of 1944, designed to help reintegrate World War II veterans into civilian life, was instrumental in making college education mainstream. Studies estimate that 1.4 million people-years of undergraduate training had been lost because of the war. The bill provided all veterans with dedicated payments to cover tuition and living expenses, enabling them to attend high school, college, or vocational or technical school. By 1956, just under eight million veterans had used the GI Bill's educational benefits, with 2.2 million attending colleges or universities and an additional 5.6 million engaging in some kind of training programme. In all, just over half of all veterans tapped the education benefits in some form, greatly exceeding the government's projections. Veterans accounted for as many as 49 % of all enrolled students at colleges and universities — and created demand for the growth of a world-class university system. The GI Bill also changed perceptions about college attendance, making it accessible to the average person and not simply reserved for the elite.

Source: McKinsey (2017b).

Some interesting innovations have recently appeared in adult education. Technology is already making higher education more flexible and easily available, especially to people who have historically had low access. Examples include online learning, open universities with minimal or no entry requirements, and massive open online courses (MOOCs). However, the World Economic Forum has recently found that most people signing up for MOOCs already have bachelor degrees. The workers who might benefit most from these courses, on the other hand, are not aware of them and are thus not enjoying their benefits. As we have already seen, recognition of informal skills is increasingly important to address accelerating changes in skills needs.

Case study: Cooperation between industry and universities

A good example of how business can help develop employment potential is the partnership between Starbucks and Arizona State University degrees. Starbucks offers to its employees the possibility of studying for degree, in a field of their choice which does not need have a formal link to Starbucks' business operations. This is an interesting example which is clearly linked with Starbucks' current difficulties in retaining employees in the long term, given that unemployment is currently very low in the US.

Case study: The P-Tech 9-14 school

A new model of education in the US — the P-TECH 9-14 school — is helping close the gap between young people's ambitions for college and careers and the specific skills needed by employers in high-growth industries.

In a P-TECH 9-14 school, students earn a high school diploma and an industry-recognised associate degree, and gain relevant work experience in a growing field. The schools create a seamless programme enabling students to acquire the academic, technical and workplace skills and knowledge that employers need.

The culture of a P-TECH 9-14 school is built upon high expectations for students and adults alike. Students see themselves as 'college students' and 'on a career pathway' from the moment they begin 9th grade.

Likewise, teachers, partners and parents work together to ensure that every student graduates prepared for the 21st century workplace.

Key aspects of the P-TECH 9-14 model:

Focus on careers
A student's experience in a P-TECH 9-14 school is shaped by the goal of preparing them to move into high-potential careers. Informed by current and projected industry standards, students take part in high school and college courses aligned to their career goals. Mentoring, workplace visits, job shadowing and internships are integrated into each student's preparation for the identified jobs. Engaged employer partners commit to ensuring that those who successfully complete the programme are experienced enough in their chosen field to be considered 'first in line' for jobs.

Focus on college degrees
Recognising that a college degree is essential for success in the 21st century economy, P-TECH 9-14 schools aim to provide every student with a pathway to an industry-recognised associate degree. Students and teachers are aware of the academic and personal standards needed to succeed in college, and college coursework is integrated throughout the six-year programme. In addition, it is free to students and families.

Redesigned high school experience
While P-TECH 9-14 schools offer a seamless and integrated six-year experience, the redesign of the high school programme goes well beyond the length of the programme. The model restructures nearly every aspect of schooling, including curriculum, instructional practices, teaching staff roles, support structures, the daily/weekly schedule, and long-term goals for students.

Diverse student body
P-TECH 9-14 schools are open to all students, including young people from low-income families, first-generation college students, English language learners, students with disabilities and students of colour. The school partners recognise that students will arrive with widely varying skill levels and experiences. They therefore work specifically to create support systems that help all students achieve their long-term goals.

Shared decision-making
A P-TECH 9-14 school relies on developing and sustaining healthy partnerships with and among the school district, college and one or more major employers. Successful partnerships are characterised by shared responsibility and decision-making, close collaboration and honest communication.

Source: http://www.ptech.org/

4.2. Managing the new forms of work

The organisation of work as we know it is based on models established in the previous century, which are starting to be outdated. All the components of employment and social protection (pension, health insurance, unemployment benefits, etc.), as well as the measures designed to help career transitions, are linked to a labour contract, not to the individual subject to this labour contract. For instance, adult education and lifelong learning are essentially linked to labour contracts. In addition, social partners, as the representatives of employers and employees, are the main stakeholders involved in the organisation and management of social protection. If, many analysts predict, we are going to see a substantial reduction of wage employment coupled with a move towards self-employment, then it would be better to transfer all the safety nets to the individual, in the form of a personal account. Several such schemes are currently being tested.

Case study: Individual unemployment accounts in Chile

Chile was the first country in the world with individual unemployment accounts and has the longest experience with this system. Reforms to the system in 2002 expanded coverage from barely a third of all those in work to the vast majority of people in work – while joining is mandatory for those taking up work after the reforms, it is voluntary for all who started employment before the change. However, many of the latter have joined.

Insurance is funded from three sources of contribution. Individuals pay 0.6 % of their own wages into a personal unemployment account (for a maximum of 11 years per employment). The employer pays an additional 1.6 % of the individual's wages into the same account and another 0.8 % to a general fund. The national

government adds USD 12 million annually to the general fund.

When the individual becomes unemployed, the insurance programme pays out from their account – provided that they have made at least 12 consecutive monthly payments into that account. All causes of unemployment are accepted when the individual requests payment from their own account, including voluntary termination or discharge. The amount of each insurance payment decreases over the period of unemployment, and is dependent on the length of previous employment and total payments into the insurance account. However, the payment period is limited to just five months.

Those with insufficient funds in their individual account (for any reason) can receive payments from the general fund only after emptying their personal account. Payments from the general fund are also dependent on the individual actively seeking work, and they cannot decline any job offer paying at least 50 % of their previous wages. Payment from the general fund is also available only to those who have lost their jobs involuntarily (and have not been dismissed for a particular reason). In this situation, the individual is entitled to receive two withdrawals from the general fund over a five-year period.

Temporary employees work under slightly different rules. They do not contribute themselves, though their employer pays a 3 % fee (based on the individual's wages) into their personal account, which follows the employee to their next job as well. They cannot access the general fund and so receive no government funding.

Source: http://www.reforminstitutet.se/en/individual-unemployment-accounts-in-chile/. Last accessed on 1 August 2018.

Some jobs may disappear, but work is more important than ever, simply organised differently. New ways of working emerge on digital platforms and the collaborative economy, with more part-time and freelance work and self-employment. For an ever-increasing number of workers, this replaces the traditional employer-employee relationship. The result is more flexibility, or an improved work-life balance, and of course, supplementary income. However, there are also some challenges.

Freelance and self-employed workers are more vulnerable than permanent employees. Employers now have access to a vast pool of 'cheap(er)' talent, without the lengthy recruitment process. However, issues of job security, professional stability and sufficient financial compensation for work done clearly arise.

The question, therefore, is who speaks for the self-employed and how an equivalent of collective agreements can be established?

The EPSC (2018a) points out that proponents of cooperatives and other business models characterised by greater empowerment of workers argue that technological gains need not automatically lead to societal polarisation. Rather, cooperatively owned and operated digital enterprises, for example, hold the promise of re-tuning incentives towards better outcomes for both users and workers, while shifting away from profit maximisation for a narrow set of external investors. These ideas are already being put into practice across a range of occupations, with cooperative models gaining a foothold among ride-hailing apps, a range of care and domestic workers, IT services and freelance workers.

Advances in automation technologies, such as increased versatility and dexterity of robots, hold out the promise of improvements in occupational health and safety as well. Particular benefits include substituting robots for people working in hazardous environments, such as space or the nuclear industry. Robots are already being used to perform repetitive and monotonous tasks, to handle radioactive material or to work in explosive atmospheres. As robot dexterity increases, so will the range of dangerous jobs from which humans can be relieved. While increased automation has benefits from an occupational health and safety perspective, there are some challenges as well. These include devising new working methods for employees to work with robots (such as the collaborative robots in the automotive industry, see case study). These are essential, so that workers understand the capabilities and limitations of cobots.

Case study: UberEngage

UberENGAGE is a pilot project Uber is currently running in the UK to provide a new way for their drivers to share feedback with Uber. The plan is for each UK city where Uber operates to have an Advisory Group of 5 experienced local drivers. They listen to drivers' needs and ensure their voice is heard across the wider business. A charter has also been drawn up, which outlines the key qualities of an UberENGAGE Adviser. Drivers can submit applications to become members of the Advisory Group in their city to an independent review board, which oversees the whole pilot project. The independent review board consists of three external experts, three partners from Uber's workshop phase, and three Uber staff. They meet four times a year, scrutinise the application process for the Advisory Groups and provide advice and feedback on improving the programme.

Source: Uber (https://www.uber.com/en-GB/drive/resources/uberengage/)

CHAPTER 5

FOSTERING AI ECOSYSTEMS IN EUROPE

The chapter at a glance

Have you ever wondered how Europe compares to the other major players when it comes to the development of AI? Are we better or worse? What are our continent's advantages? Which areas should we focus on to support EU industrial development?

Europe's competitive edge in artificial intelligence depends on the quality of our research, the excellence of our universities in disseminating knowledge and preparing students for jobs involving the use or development of AI systems. The chapter examines the state of play of AI ecosystems in Europe, looking into the need to attract talent, to galvanise efforts to create European-scale laboratories on artificial intelligence, and manage the repercussions of recent EU legislation on the development of the AI sector in Europe. It then focuses on key areas of a renewed EU industrial strategy, which could boost AI development on the continent.

An essential part of developing successful AI ecosystems in Europe is transposing technological advances into the real economy. SMEs represent the backbone of the EU economy and are its main engine for growth and employment. The impact of the AI revolution on SMEs in Europe has so far been uneven, and a significant portion of the European economy might thus miss the potential benefits to

productivity offered by AI. The chapter thus also examines the challenges and opportunities for SMEs from the coming AI transformation of the economy.
While Europe has some distinct advantages and disadvantages in AI development, a key area where a new industrial policy for Europe could help is hardware and computing power. There are currently no European companies that are world leaders in computer hardware and more specifically in semiconductors. Another key factor European industries will need to tackle in order to reap benefits in emerging market segments is the development of standards.

5.1. The case for immigration – EU blue card

Europe's competitive edge in artificial intelligence depends on the quality of our research, and on the excellence of our universities in disseminating knowledge of it and in preparing students for jobs involving the use or development of AI systems. However, there is a worldwide scarcity of AI expertise and in fact keen competition to attract the best AI talents.

In Europe, it seems that there is no sense of urgency on this. Some of our best researchers/students leave because they are proposed extremely well-paid jobs in North America combined with attractive family packages. Meanwhile, our complex national immigration rules deter many potential AI experts from coming to work here.

In Canada, the federal government has recently introduced a fast-track system that allows AI experts to get a visa in 2 weeks. This is combined with visa facilities for spouses and very generous support mechanisms to facilitate the arrival and installation of their families. A similar scheme exists in Australia with a three-week deadline.

In contrast, the proposed EU blue card seems to pale in comparison with those schemes, and anyway negotiations on its adoption are proving to be protracted and inconclusive so far.

Case study: Immigration of skilled labour force in Canada

In June 2017, Canada's federal government introduced priority processing of work permits under its global skills strategy. As a result, skilled workers will receive their Canada work permits and Canada visa applications processed within 2 weeks.

Essential elements of the 'Global Talent Stream':

- Two-week standard for processing Canada work permit applications (and Canada visa applications when applicable) for highly skilled talent.
- Dedicated service for companies looking to make significant job-creating investments in Canada.

- Dropping of the work permit requirement for short-term highly skilled work (30 days or less in a 12-month period), and brief academic stays.
- Companies applying for workers through the Global Talent Stream will have access to the new streamlined application process that will provide:
    - Client-focused service to help guide eligible employers through the application process and the development of the Labour Market Benefits Plan, with a service standard of 10 business days.
    - Eligibility for workers to have their work permit applications processed in 10 business days.

The Global Talent Stream is part of a broader global skills strategy to provide direct help to Canadian start-ups to thrive.

Source: https://www.immigration.ca/global-talent-stream-2-week-canada-visa-application-processing/

5.2. SMEs and the AI transformation in Europe

SMEs represent the backbone of the EU economy and are its main engine for growth and employment. In 2015, 99 % of all companies in the EU employed fewer than 250 people, while 94 % of these companies were independent. However, most SMEs are lagging behind (or not taking part altogether) in the uptake of new AI technologies in their business practices and processes. As proper statistics for the uptake of AI in companies are lacking, a useful proxy is the share of companies with high levels of digital intensity. In 2017, the share of SMEs with high levels of digital intensity in the EU was just over 20 %, with large variations among Member States (from 10.8 % in Latvia to 40.6 % in Denmark). A significant portion of the EU economy might thus miss the potential benefits to productivity offered by artificial intelligence.

The potential benefits to productivity are indeed manifold. They come from improving efficiency, optimising business processes and reducing the amount of time necessary to complete a task. For example, AI's capacity to process huge amounts of data in the blink of an eye is unmatched by human capabilities in this regard. This can be applied to paperwork, file and meeting minutes, or responding to parts of the mountains of emails, to name but a few areas. AI can also offer more comprehensive insights into processes, which can lead to better business decisions. In addition, AI can be used to transform sales, generating new leads or improving customer service by offering 24/7 personalised customer support. For example, a chatbot developed by Baidu was used by a local bank branch in one of China's cities to call about 1 000 potential customers a day over a period of 2 months (a total of about 38 000 customers). This significantly improved the branch's performance and economic results, bringing in new customers, who were out of reach for the limited number of human employees working in customer service.

The challenges related to an increased uptake of AI by SMEs are almost as numerous as the benefits. In a world economy where data is the new oil, SMEs often struggle to access large datasets of good quality, which puts them at a competitive disadvantage with big (mostly US-owned) technology companies. In the meantime, the three US internet giants Google, Facebook and Amazon use their size, financial clout, access to AI talent and data to increasingly turn into data monopolies. Large companies also tend to develop their own data platforms, which they keep for themselves, resulting in interoperability issues and competing standards in the use of AI, and reduced access for SMEs. From a policymaking perspective, the interplay between competition policy and AI will become increasingly salient in the short and medium term. In September 2018, the Commission launched a preliminary investigation against Amazon for possible abuse of dominant position and anti-competitive behaviour. The focus of the investigation revolves around the possibility that Amazon uses its platform to harvest data from third-party vendors and then use this data to push its own products. Such behaviour, if proven to exist, would be especially detrimental to SMEs, which are the majority of third-party vendors on Amazon. SMEs also find it much harder than big companies to comply with regulations (such as the GDPR for example).

In an overall shortage of AI developers, small and medium-sized companies find it especially difficult to attract the needed talent to help them transition to AI. In addition, very often SMEs have access neither to the necessary funding nor to advice on how to utilise AI in their business models. AI management consultancies exist (such as ElementAI in Canada for example) but their services are limited to Fortune500 companies. There is an increasing need to provide SMES with access to algorithms, which in most cases they cannot develop on their own. The Commission proposal in the Digital Europe programme to develop common 'European libraries' of algorithms that would be accessible to all is a welcome first step in this regard. While such open libraries are also provided by private actors (such as Google's TensorFlow for example), issues of data ownership and access on these private platforms can reinforce the development of data monopolies mentioned above.

Case study: Digital innovation hubs

Europe can gain decisive competitive advantages internationally if it is capable to generate a wave of bottom-up digital innovations involving all industrial sectors. The digital revolution brings opportunities for big and small companies, but many of them still find it difficult to know which technologies to invest in and how to secure financing for their digital transformation.

Around 60 % of large industries and more than 90 % of SMEs feel that they are lagging behind in digital innovation. Similarly, there are strong digitalisation discrepancies between industrial sectors.

Digital innovation hubs (DIHs) can help ensure that every company, small or large, high-tech or not, can grasp the digital opportunities. With technical universities or research organisations at the core, DIHs act as one-stop shops where companies – especially SMEs, start-ups and mid-caps – can access technology-testing, financing advice, market intelligence and networking opportunities.

Member States and regions play a key role in establishing DIHs that support the digital transformation of industry in their regions. The role of the European Commission is to link the DIHs in a strong pan-European network. For this, the European Commission is investing EUR 100 million per year from 2016 to 2020.

Helping companies accomplish their digital transformation also means ensuring that their employees have the necessary skills to work with new ICT technologies. DIHs can play a key role in this respect, as they offer access to training and skills development. This element will be further reinforced by the European network of such hubs.

The Digitising European Industry initiative aims to ensure the presence of a DIH in every region by 2020. However, many regions are as yet under-represented in the existing network. To help them, the European Commission has launched training programmes for new DIHs. These efforts will receive an EUR 8 million boost under the EU's Horizon 2020 research programme to support new DIHs in under-represented regions with strong industrial activity.

In 2019, Member States are also expected to identify AI digital innovation hubs in their territory.

Source: European Commission; https://ec.europa.eu/digital-single-market/en/digital-innovation-hubs

5.3. Creating AI hubs in Europe

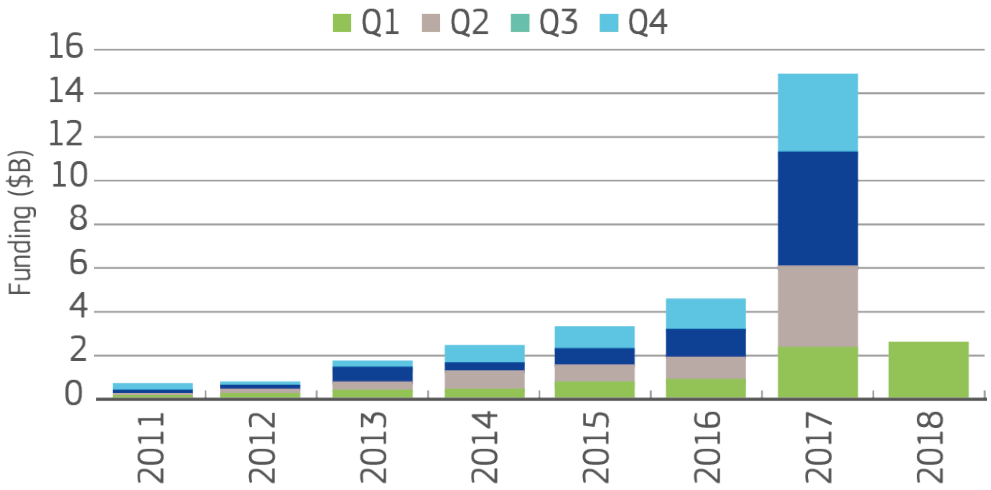
All developed economies recognise the game-changing nature of artificial intelligence. Many countries have recently released national strategies (see Annex I) to make sure they reap the benefits of AI in terms of enhanced productivity. Everybody recognises that not keeping up in this race means a substantial loss of competitiveness and will eventually result in unemployment in all sectors of the economy.

However, the size of the investments and the decisions to create national AI hubs vary hugely across developed countries. While Europe invested USD 3 to 4 billion in 2016, USD 8 to 12 billion were invested in Asia, and USD 15 to 23 billion were invested in North America in the same period. Although there are excellent universities in Europe, there is no research centre dedicated to AI with sufficient scale and international visibility to attract and retain the best researchers in the world and to mobilise the support of large corporations. In

addition, the main problem today is the shortage of competent AI professionals and a shortage of AI specialists in general. With the scale of the investments made available (see Graphs 15 and 16) in other parts of the world, and the aggressive pursuit of the best researchers in AI in some countries, it is clear that Europe is already lagging behind.

Graph 15: Overall artificial intelligence funding grew at a CAGR of 83% from 2012-2017

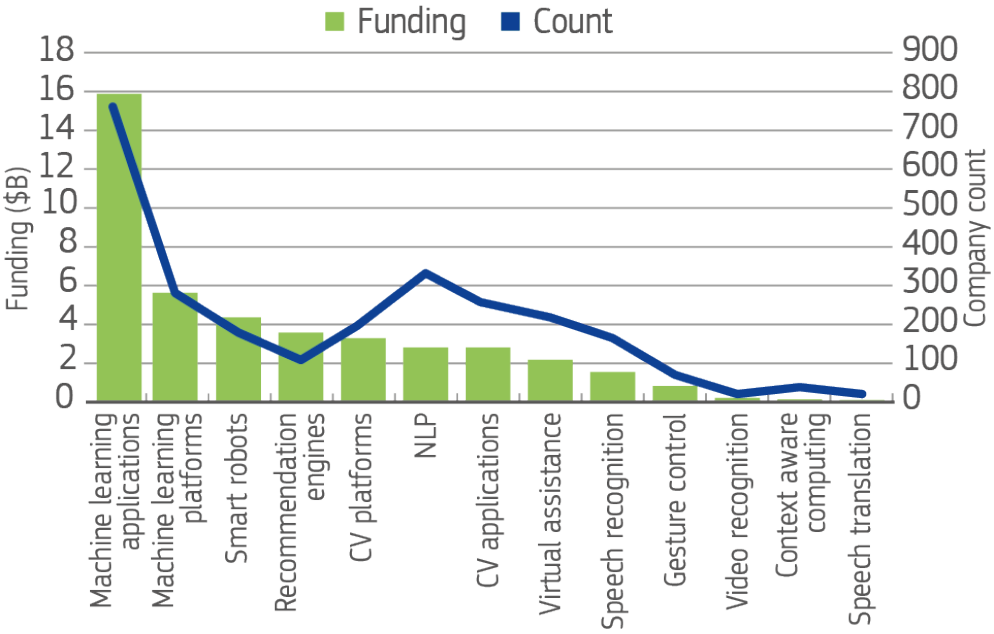
Artificial intelligence Annual Funding Over Time



Data cumulative through March 2018, source: Venture Scanner

Graph 16: Artifical Intellligence

Total Funding and Company Count by Category



Data cumulative through March 2018
Source: Venture Scanner

AI is emblematic of fast-developing technologies, which require a close and fluid connection between investors, academics, and researchers in order to benefits jobs and growth creation. In a field subject to extremely rapid evolution, many ideas are produced by research, but only a portion of these can be turned into innovations that can become profitable businesses. At the same time as these ideas are generated, it is essential to bring large groups of students in on the latest advances in the technology, and to involve them in their development. They can then use these latest advances in future jobs or contribute to developing further advances. At the same time, it is essential to involve investors, venture capitalists or more traditional investors, as they have the expertise in how to transform innovations into viable business operations and help identify at a low cost and fairly quickly those innovations that have no immediate future.

This is why systems like the Creative Destruction Lab (CDL) in Toronto, Canada are very successful. CDL is a non-profit organisation, running on donations from corporations. On the technological side, the National Research Council of Canada is screening projects at the beginning of the process, with academics involved in providing advice; on the business side, CDL is different from an incubator in that it does not take equity - instead, it focuses on mentoring start-ups and helping them to scale up, with the mentoring and advice provided by venture capitalists.

Similar successful organisations exist in other parts of Canada. Two examples of these are MILA and IVADO, both attached to the University of Montreal. The aim is to bring together the best academic researchers with industry professionals and develop cutting-edge expertise in all aspects of artificial intelligence, notably data science. Both institutions provide opportunities for collaboration between academic experts, students and investors. One important element is the possibility offered to academics to work part-time in the university and part-time as advisors to companies.

In Hong Kong, the Cyberport is a 100 % government-owned incubator that runs in a commercial way, generating revenues and making investments. It is self-sustained and does not receive grants from the government for its operations, and its profits are constantly reinserted to support innovative initiatives. Its revenues come from charging companies for putting them in contact with start-ups and from reproducing the Cyberport's model abroad. The Cyberport offers financial assistance, support from a team of experts, rent-free working spaces, networks, collaboration opportunities and other subsidised services such as off-site subsidies to support start-ups that are not based in the incubator. Different funding schemes are available. The Cyberport also has educational purposes, as it collaborates with universities to foster a start-up mentality for students. For instance, the Cyberport University Partnership Programme runs a competition for students to win contracts with businesses.

Europe is moving in a similar direction, albeit rather more hesitantly. To address this, the Commission launched the European Innovation Council (EIC) pilot, which supports top-class innovators, entrepreneurs, small companies and scientists with bright ideas and the ambition to scale up internationally. In the period 2018-2020, the EIC will provide EUR 2.7 billion to breakthrough innovations.

The academic community in Europe has also galvanised efforts to address the need for dedicated centres of excellence in AI. One idea recently put forward is to create a European-scale laboratory on artificial intelligence, ELLIS; however, the focus appears to be limited to fundamental research, and without any business angle. This would miss the essential point about the need for a genuine osmosis between business, research and universities. Another recent initiative – CLAIRE, seems to make provision for closer collaboration with industry, to transfer quickly and efficiently new results and insights from fundamental research.

Box 4: ELLIS and CLAIRE

At present, there are two competing academic approaches to a European effort on AI – an initiative to establish a 'European Lab for Learning and Intelligent Systems' **(ELLIS)** and a Call for the Establishment of a 'Confederation of Laboratories for Artificial Intelligence Research in Europe' **(CLAIRE)**.

The ELLIS Initiative is focused around learning-based approaches to AI. Its mission is to benefit Europe in two ways – (i) by fostering the best basic research to be performed in Europe, to enable Europe to shape how machine learning and modern AI change the world; and (ii) by having economic impact and creating jobs in Europe. The ELLIS founders believe this can be achieved by outstanding and free basic research, independent of industry interests.

The vision of ELLIS includes performing fundamental research in modern AI, attracting top international industry research labs, and spawning start-ups that will become major players in the future. It will thus drive excellence in Europe's research and use of machine intelligence to foster economic development and improve the lives of people.

ELLIS wants to be a top employer in machine intelligence research, on par with Berkeley, Stanford, CMU, and MIT. It aims also to be a world-class venue for obtaining training in the field, in conjunction with universities. It also wants to develop a highly attractive European PhD programme, and to strive and retain the best graduates in order to produce the next generation of senior scientists.

In addition to researchers and faculty from the partner institutions, ELLIS will offer permanent employment to outstanding individuals early on and train them in both academic and non-academic skills. These researchers will receive an adjunct faculty

position from one of the partner institutions. They will also be offered a complete career path within ELLIS, paralleling those found in tenure-track programmes, from the equivalent of the rank of assistant professor to that of full professor. The aim here is to avoid brain drain to the US.

CLAIRE's vision aims to make European research and innovation in artificial intelligence among the best in the world, encompassing all of AI and all of Europe, and with a strong focus on human-centred AI.

The concept behind CLAIRE is partly inspired by CERN. CLAIRE is to comprise a network of centres of excellence strategically located throughout Europe and a new, central facility that serves as a hub, providing state-of-the-art infrastructure, and fostering the exchange of ideas and expertise. The 'centres of excellence in AI' would play strong regional or national roles as hubs for the members of the collaborative network in their region. A new facility, the 'CLAIRE Hub', would be created that serves as a highly visible and vibrant focal point for the collaborative network. Here, top scientific personnel at all levels and from all partners would find an outstanding research environment for AI, where they can work together face-to-face for periods of time. This hub should provide cutting-edge infrastructure and support, but would not have permanent scientific staff.

While ELLIS focuses on machine learning techniques, CLAIRE believes that Europe should build on its existing strengths across the full spectrum of AI, covering all machine learning, knowledge representation and reasoning, search and optimisation, planning & scheduling, multi-agent systems, natural language processing, robotics, computer vision and other areas.

CLAIRE also stresses the need for a set of principles and guidelines on the responsible use of AI, a sort of 'AI Manifesto'. This manifesto should stipulate limits of responsible use and anticipate the consequences of deploying specialised AI systems and of creating general, human-level AI. It should also determine how to assess quantitatively and qualitatively whether AI systems or agents comply with those limits.

ELLIS and CLAIRE have agreed to endorse each other's proposals, acknowledge their complementary nature and coordinate efforts, while preserving the unique characteristics of the two proposals. ELLIS and CLAIRE both emphasise the importance of excellence in fundamental research because economic leadership relies on technical leadership, especially in AI.

Sources: https://ellis-open-letter.eu/letter.html ; https://claire-ai.org/

5.4. Towards a new industrial policy for Europe

Industry take-up of AI is very important for Europe, as the continent is currently lagging behind both the US and China. In this light, the renewed EU industrial policy strategy launched in 2017 is a useful first step forward.

Several elements in the renewed strategy are key for AI development and take-up. Reinforcing industry's cybersecurity will be increasingly important in a digital future, where cyber espionage is not only limited to the online world but also spreads to physical products (e.g. reports of China's attack on US technological supply chains, which allegedly affected iPhones, among other products[35]). The proposal for the free flow of non-personal data (see the case study on the EU data economy) is another important element supporting AI development.

The agreement reached by co-legislators on 20 November 2018 to create a European framework for the screening of foreign direct investments is a vital part of a renewed EU industrial policy, as it allows critical infrastructure for AI development, such as communication technology and robotics, to remain in European hands. It is regrettable that this comes too late for some key companies, such as Kuka Robotics, which have already been acquired by non-European owners.

While Europe has some distinct advantages (i.e. strength in fundamental research and in the business-to-business application of new services and technologies) and disadvantages (talent leakage, fragmentation of efforts, etc.) in AI development, a key area where a new industrial policy for Europe could help is hardware and computing power. Steps have already been taken to support the development of strategic hardware components at European level. These include the public-private partnership on Electronic Components and Systems for European Leadership (ECSEL) and the European High-Performance Computing (EuroHPC) Joint Undertaking. ECSEL aims to secure the supply of key technologies supporting innovation through ensuring Europe's independence in the field of electronic components and systems. EuroHPC, on the other hand, pools European resources to develop top-of-the-range exascale supercomputers for processing big data, based on competitive European technology.

Nevertheless, there are currently no European companies that are world leaders in computer hardware and more specifically in semiconductors. The largest supplier of components for the world's fastest supercomputers is a Chinese company – Lenovo (with 140 out of the world's fastest 500 supercomputers).

Chips are essential for the further development of AI and all major players are investing in new generation processors specifically tailored for AI use – Google's TPUs, Amazon's

35 https://www.bloomberg.com/news/features/2018-10-04/the-big-hack-how-china-used-a-tiny-chip-to-infiltrate-america-s-top-companies. Last accessed on 20 March 2019.

Inferentia, Alibaba's AliNPU, to name but a few. A key aspect is that such semiconductors will not be sold but rather computing power will be rented to consumers via the cloud, which will further reinforce the leading companies' hold on AI development. As there are no leading European chip manufacturers, there is a clear role for EU industrial policy to play in this regard. The European Processor Initiative, a consortium to develop European microprocessors for future supercomputers, could serve as an example for a similar initiative for AI-specific chips developed and built in Europe. These could greatly boost European efforts for strategic independence in the AI race. Another important development in this regard is the recent approval by the Commission of the plan of France, Germany, Italy and the UK to give EUR 1.75 billion public support to joint research and innovation project in microelectronics[36]. This is a project under the Important Projects of Common European Interest framework implemented by the Commission in 2014.

The lack of European companies for semiconductors that can compete on a global scale (combined with access to data which is limited due to regulatory restrictions, as compared to global competitors) makes it harder to develop AI in the EU. The next Google or Apple cannot be developed in Europe under these conditions. It is too late for that and Europe should instead focus on its competitive advantages. These include the manufacturing and construction sectors, automobiles and pharmaceuticals to name a few – all areas that we need to support via an EU industrial policy.

To do so, we need to put into question the competition and state aid dogma. This is pressing due to the distorted international conditions for competition in other countries. Companies, such as Huawei or Baidu, have been supported in China into becoming the national champions that they are. Therefore, the time is ripe to also support European champions. There is a clear majority of Member States that support such an approach. During a ministerial meeting in Paris in late December 2018, a group of 19 EU countries called for "new political impetus" to ensure European industry remains competitive on a global level[37]. This was followed in February 2019 by a 'Franco-German Manifesto for a European industrial policy fit for the 21st Century'[38]. These developments are certainly a step in the right direction.

The development of standards is another key area that European industries need to make progress in to reap benefits in emerging market segments. AI development and take-up in Europe could benefit from data standards, data formats and standards for metadata, to name a few. China is already working in this area, with the Ministry of Industry and IT's Chinese Academy of ICT coordinating the work of cooperation platforms, such as the China Artificial Intelligence Industry Innovation Alliance, which aim to promote the standardisation

36 http://europa.eu/rapid/press-release_IP-18-6862_en.htm
37 https://www.euractiv.com/section/economy-jobs/news/19-eu-countries-call-for-new-antitrust-rules-to-create-european-champions/. Last accessed on 20 March 2019.
38 https://www.gouvernement.fr/en/a-franco-german-manifesto-for-a-european-industrial-policy-fit-for-the-21st-century. Last accessed on 20 March 2019.

process in industry. Work in Europe to modernise the standardisation system is ongoing, with five priority areas for standards in the digital economy - 5G, cloud computing, internet of things, data technologies and cybersecurity. Successfully completing this work would be very important for providing interoperability and 'first-mover' advantage to European industry in the development of AI technologies and products.

Beyond a revamped industrial policy, the AI sector in Europe could also benefit from the completion of the Single Market. It is the biggest asset that the EU economy has, but in many areas it remains unfinished. This poses problems for all companies, but especially for start-ups and SMEs. In sectors where a genuine single market exists, companies grow and thrive. The current construction of the Single Market does not support companies developing new emerging technologies to succeed, as they lack sufficient scale. As the Lisbon Council (2018) mentions, many of the factors that hold back the performance of the Digital Single Market are not specific to the digital sector. Rather, they have to do with the general conditions for businessmen to work across borders without high regulatory costs or barriers.

Box 5: Public-private partnerships (PPPs) in robotics and big data

Robotics PPP:

In the 'Public Private Partnership in Robotics', the European robotics industry, research, academia and the European Commission have joined together to launch a new research, development and innovation programme in order to strengthen the competitive position of the European robotics industry and foster the excellence of its science base.

The objective of the PPP is to provide a platform for the industrial and academic community to develop a common roadmap for robotics in Europe and to identify the means to implement this roadmap with public support.

The initiative includes action covering the full innovation cycle, from research to industry-led R&D down to testing and piloting of innovative robotic technologies in real settings. It also includes action to ensure a faster uptake of innovations, such as support for pre-commercial procurement in areas of public interest (security, healthcare, etc.).

The public side is represented by the European Commission's Directorate-General for Communications Networks, Content and Technology, while the private sector is represented by euRobotics aisbl. The outcomes of the consultations between the different parties within the PPP resulted in a strategic research agenda for robotics in Europe, integrated into the Horizon 2020 work programme.

Big data PPP:

The 'Big Data Value Public-Private Partnership' aims to create a functional data market and data economy in Europe, in order to enable Europe to play a leading role in big data in the global market.

Big data is a key economic asset for achieving competitiveness, growth and jobs due to its potential for impact and as an enabler for both multiple-sector and sector-specific gains. Mastering the creation of value from big data will be a cornerstone in future economic development and societal well-being.

Europe is not playing the role it should in the global market. Only 2 out of the top 20 companies changing lives and making money out of big data are European. For this situation to be reversed, Europe needs to strengthen all parts of the 'data value chain' so that a vibrant big data value ecosystem and data-powered innovative business models can evolve. That includes people and organisations involved in data whatever their role, be it producing, analysing, using or creating value from data.

The Big Data Value PPP is a partnership between the European Commission and the Big Data Value Association (BDVA), the association of the European big data community, which includes data providers, data users, data analysts and research organisations. The association is a non-profit, industry-led organisation whose members are leading European companies and R&I organisations. The BDVA is open for additional companies and research organisations to join.

Source: European Commission; https://ec.europa.eu/digital-single-market/en/robotics-public-private-partnership-horizon-2020; https://ec.europa.eu/digital-single-market/data-public-private-partnership

5.5. Data protection and data access

The General Data Protection Regulation (GDPR) entered into force in May 2018 and has been widely celebrated as a major step forward in protecting all EU citizens from privacy and data breaches in an increasingly data-driven world.

The jurisdiction of the GDPR has been extended as it now applies to all companies processing the personal data of data subjects residing in the EU, regardless of the company's location. Organisations in breach of the GDPR can be fined up to 4 % of the annual global turnover or EUR 20 million. The conditions for consent have been strengthened, notification of breaches has become mandatory, and the right to be forgotten has been introduced. Data can only be used for the purpose for which they have been collected.

These are indeed major advances in the protection of the privacy of European citizens. The GDPR is seen as a standard creating trust, which is paramount for the successful development of AI. However, there may be some drawbacks for the development of AI systems that deserve to be monitored. It is not a coincidence that Mark Zuckerberg praised the new European legislation in his hearing in the European Parliament. Evidence from the online advertising market also suggests that Google might have reinforced its dominant position following the introduction of the GDPR[39]. This legislation could result in a trade-off between fostering public trust and SME development, as it creates a bias in favour of the largest incumbent players, who have the technical capacity to comply with the new rules and have the best access to data. Consumers themselves may prefer to give their data only to the likes of Google, Facebook and Amazon, which may result in a further reinforcement of their oligopolistic position, to the detriment of small players.

Another aspect of the implementation of GDPR is the need to ensure consistency of decisions taken by the different data protection authorities in the future. If national approaches interpreting the GDPR are too divergent, this could in effect force companies to comply with multiple regulatory regimes, which will increase costs, uncertainties and could further hamper the development of the AI sector in Europe. Similar concerns have started to emerge on the other side of the Atlantic as well, as several states have started to legislate on data protection (most notably California). This has brought calls for federal legislation at national level to avoid fragmentation of outcomes and differing levels of protection.

Other EU legislation, such as the EU copyright reform, also has a potential impact on access to data in the EU. Article 3 therein limits the exception to copyright for text and data mining only for research/scientific purposes. Text mining and data mining are increasingly important for tasks such as analysing big data sets and training artificial intelligence systems. The narrow application of Article 3 could mean that machine learning systems could infringe on copyrights in the future, as to train an algorithm for visual recognition, for example, one needs access to millions of photographs, which are all protected by copyright. Not enabling other actors such as companies, journalists or independent researchers to use text mining and data mining could hamper the development of AI in Europe. It could also deny European research and AI-based companies a level playing field from an international perspective and harm their competitiveness.

As data is the central element for the development of any artificial intelligence system, monitoring the implementation of the GDPR and other EU legislation is important to make sure that it provides the right balance between data privacy and optimal development of AI systems by all interested market players. US and Canadian legislation is much weaker than that of the EU, while in China, data protection is almost non-existent: these facts, which are quite positive for EU citizens from a privacy perspective, may also put the EU companies in

39 https://cliqz.com/en/magazine/study-google-is-the-biggest-beneficiary-of-the-gdpr. Last accessed on 20 March 2019.

a weaker position when building their AI systems. In any event, this means that in any future trade negotiations privacy rules should be included in the agenda with the objective of including a data privacy chapter. The EU-Japan Economic Partnership Agreement, which was concluded in July 2018, is a good example in this regard. Future trade agreements could go further than this and include a digital chapter, in which ground rules are established on issues such as access to data, copyright, data protection, non-discrimination and net neutrality.

Case study: Building a European data economy

Building a European data economy is part of the digital single market strategy. The initiative aims to enable the best possible use of digital data's potential to benefit the economy and society. In this initiative, the Commission intends to unlock the re-use potential of different types of data and its free flow across borders to achieve a European digital single market.

Digital data are an essential resource for economic growth, competitiveness, innovation, job creation and societal progress in general. The value of the EU data economy in 2016 was EUR 300 billion, representing 1.99 % of GDP. If favourable policy and legislative conditions are put in place in time and investments in ICT are encouraged, the value of the European data economy may increase to EUR 739 billion by 2020, representing 4 % of the overall EU GDP.

As stated in the mid-term review of the digital single market strategy, the Commission intends to support the creation of a common European data space — this will be a seamless digital area with the scale to enable the development of new products and services based on data. Data should be available for re-use as much as possible, as a key source of innovation and growth. The measures announced in the 'Towards a common European data space' Communication cover different types of data and therefore have different levels of intensity. These measures include:

- a review of the Directive on the re-use of public sector information (PSI Directive);
- an update of the 2012 Recommendation on access to and preservation of scientific information; and
- guidance on sharing private-sector data among companies and with public-sector bodies for public interest purposes.

These initiatives are linked to the 2017 Commission proposal for a Regulation on the free flow of non-personal data in the EU. Once adopted, the proposal will ensure that no barriers such as data localisation restrictions will impede the development of the European data economy.

Promoting the re-use of public and publicly funded data

In the EU, the public sector is one of the most data-intensive sectors. As a result, it holds vast amounts of data, known as public sector information (PSI) which, depending on national access regimes, may be open. The re-use of such data can contribute to the growth of the European economy, the development of artificial intelligence and the fight against societal challenges.

The re-use of such data is governed by Directive 2003/98/EC on the re-use of public sector information. The European Commission is reviewing the Directive in order to encourage access to and re-use of public and publicly funded data. To support the review, a public consultation was carried out in the second half of 2017. Based on the conclusions of the consultation, the Commission has published a proposal on revising the PSI Directive to make more public and publicly funded data available for the creation of a common data space in the EU. In January 2019, negotiators from the Parliament, the Council and the Commission reached an agreement on the revised PSI directive that will facilitate the availability and re-use of public sector data.

Assessing the need for further action on access to and re-use of private sector data

In the 'Towards a common European data space' Communication, the Commission sets out a series of key principles that could make data sharing a success for all parties involved, in both business-to-business (B2B) and business-to-government (B2G) situations.

The Commission aims to:

- ensure fair and competitive markets for internet of things objects and for products and services that rely on non-personal machine-generated data created by such objects. The Commission suggests a number of draft principles for companies to consider when drafting relevant contracts;
- assist public bodies in accessing and re-using private-sector data, so as to guide policy decisions or improve public services. The Commission considers that compliance with the principles in the Communication would support the supply of private-sector data under preferential conditions

Removing data localisation restrictions: the free flow of data

Free flow of data means the freedom to process and store data in an electronic format anywhere in the EU. This is necessary for the development and use of innovative data technologies and services. Thus, the proposal for a Regulation on the free flow of non-personal data will lay the foundations of the common European data space. This Regulation introduces the principle of the free flow of

non-personal data across borders into EU law, thereby establishing the free movement of non-personal data in the same way as the General Data Protection Regulation does for personal data.

In addition to the free flow of non-personal data in the EU, the measures announced in the Communication 'Towards a common European data space' will unleash the full power of the EU's data economy, boost the competitiveness of European businesses and further modernise public services.

Source: European Commission;
https://ec.europa.eu/digital-single-market/en/policies/building-european-data-economy

CHAPTER 6

RENEWING THE ORGANISATION OF WORK AND ADDRESSING SOCIETAL IMPLICATIONS

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The chapter at a glance

Have you ever wondered what implications AI and robotisation will have for society and the world of work?

Who will pay for managing the transitions workers will need to undergo, and the necessary accompanying social protection measures? With the increasing share of capital and declining share of labour in income, how do we make sure that governments have the money to fund their social security systems? How do we ensure adequate social protection for people in non-standard employment? How do we make sure that the important role of social partners is maintained in the future? What do we do about growing inequality? Is universal basic income relevant for the age of AI? Do we need to adjust EU legislation? These are some of the questions that this chapter tries to answer.

To promote social acceptance of new technologies, policymakers would need to tackle the real and perceived threats associated with AI. There is a strong psychological element of fear, which could undermine or derail the uptake of AI in Europe. To overcome this, improving people's understanding of, accessibility to and trust in AI technologies will be paramount. Addressing it would also tackle the rising threat of inequalities inherent in the new technologies.

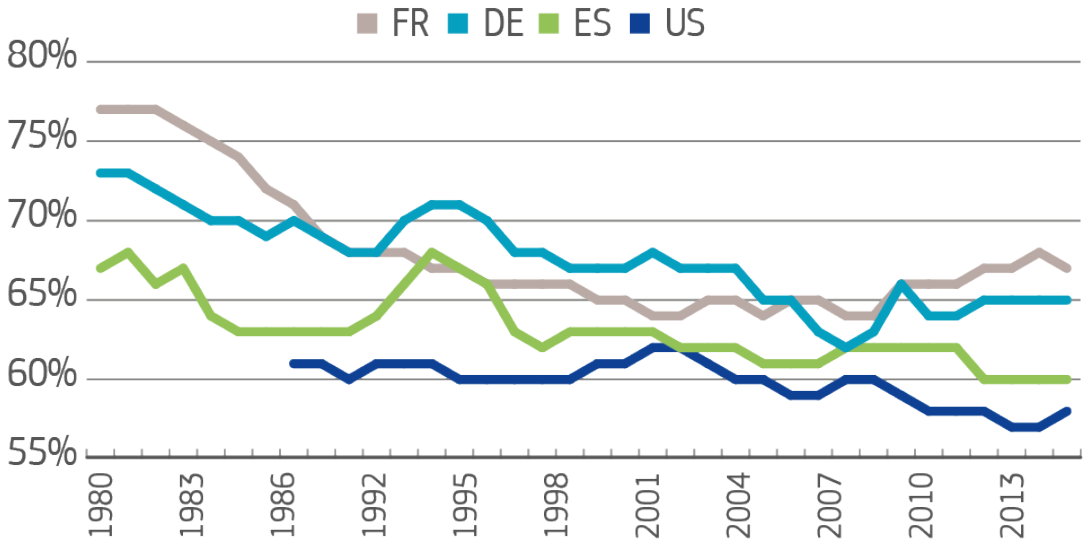
Beyond the debate on the future of work, there is a growing anxiety about some of the social implications of artificial intelligence, such as the possible intrusions in privacy, and the risks of discrimination and exclusion, which could increase when using AI. A clear need exists to improve digital understanding and data literacy in society. If we are to make certain that we understand AI systems, whose influence over our lives and societies grows constantly, we need to ensure that all different groups in society participate in their development. In this way, such systems will also serve us fairly rather than perpetuate and exacerbate prejudice and inequality.

A very important part of successfully managing the transition workers need to undergo comes from the need to address social transformations stemming from AI. Making social safety nets relevant to the new realities of work is a key deliverable in this regard.

Another very important aspect of the changes brought about by AI and automation is that of funding – who pays for managing the transitions workers will need to undergo, and the necessary accompanying social protection measures? With the increasing share of capital and declining share of labour in income (see Graph 17), how do we make sure that governments have the money to fund the social security systems?

Graph 17: A decreasing share of total income is labour income

Share of labour income in total gross value added



Source: ESDE 2018

As was already mentioned on several occasions above, job displacement due to automation raises concerns about inequality. Increasing employment in high-skilled cognitive jobs and low-skilled service occupations — with little in the middle — can lead to a polarised labour market. The House of Lords (2018) report on AI points out that automation is likely to mean that highly skilled workers, who are typically more adaptable and who will have a larger stake in AI, are likely to take a growing proportion of income. At the same time, low-skilled workers, who have typically struggled to adapt to technological change and will have at least some work taken away from them by machines, are more likely to struggle. The potential of AI and the new wave of automation to significantly increase inequality is something that governments need to address urgently. To address the rising inequality in a digital age, it is very important that everyone has access to digital infrastructure. As Graph 11 suggests, some of the Member States (such as Bulgaria and Romania) with the lowest percentage of poor households having a broadband connection are also the Member States with the highest income inequalities.

How do we ensure adequate social protection for people in non-standard employment? How do we make sure that the important role of social partners is maintained in the future? What do we do about growing inequality? Is universal basic income relevant for the age of AI? What is the role of the State in all these aspects? These are some of the questions that this chapter tries to answer.

6.1. Managing the social dialogue

Social dialogue, when constructive and managed in a spirit of responsibility, is the most effective way for companies to ensure economic performance and for their employees to receive a fair share of the economic performance they have contributed to.

Current trends everywhere in Europe show a movement towards de-unionisation. In some EU countries, it is so marked that one may question the representativeness of the unions in place. This is linked to the atomisation of the economy, with many small players in which unions are not represented, and the emergence of self-employment, for which no collective representation exists so far. In economic sectors characterised by a homogeneous workforce, the influence of trade unions is likely to continue, while in more heterogeneous sectors, it could decline further.

It is hardly possible for existing unions to represent the self-employed. Their missions are linked to labour contracts and labour legislation, in a traditional relationship with employers. In addition, the unions' starting position is often that self-employment is not genuine, and that legislation should be adopted to make it subject to labour law.

The trend towards de-unionisation means that the traditional protective role of social partners and collective bargaining is declining in many European countries, and largely absent for the self-employed. This also applies to the social partners' role in managing

social protection institutions. As a result, social protection for new forms of work is largely underdeveloped. This has long-term consequences and brings several questions to mind: how will workers build up decent pension rights? Or have adequate health insurance? And are they protected against unemployment?

As further elaborated in the ESDE (2018), the changing structure of the economy provides significant challenges to social partner organisations. Social partners, particularly trade unions, face the challenge of recruiting members and organising social dialogue of workers in non-standard employment situations. This challenge is particularly pressing in Member States where social partners' capacity is limited. Given the marked decline in union density, this is generally more of a problem for trade unions than for employer organisations, whose density has been relatively stable.

Digitalisation is blurring the distinction between sectors, and between the online and the offline economy. This poses challenges to employer representation. The ESDE (2018) points out that digitalisation enables businesses to diversify their activities and consequently operate in sectors where they were not present before. Such trends have been recorded, for example, in postal services and logistics as a result of e-commerce and the thriving market of parcel delivery. Recently, some temporary work agencies (Randstad and Adecco for example) have developed or acquired their own online platforms. This might represent an additional incentive for employer organisations to move into the online world.

Non-standard workers are more likely to be disadvantaged in terms of wealth and income than standard workers. This means that they need a strong voice to speak on their behalf. The ESDE (2018) also suggests that from the trade union perspective, the decreased share of workers affiliated could have a negative impact on trade union legitimacy not only vis-à-vis employer organisations but also governments.

In some sectors or Member States, trade unions already organise the self-employed. While generally the self-employed are not members of trade unions, the ESDE (2018) points out that trade unions are open to certain categories of self-employed people in more than half of the Member States. In some Member States, like France or Germany, the self-employed in sectors such as the performing arts and journalism are organised in sectoral trade unions. These are sectors where (dependent) self-employment is usually widespread. As more and more people work as solo self-employed in different service sectors, attempts have been made to achieve a broader representation of the self-employed as well. For example, the 'ver.di' in Germany represents standard workers and self-employed workers in much of the services sector. Developed in Belgium, SMart is a cooperative now active in 8 European countries. Its principal goal is to assist freelance workers to develop their own

activity through a secure system. It offer multiple services such as information, trainings, legal advice, a social professional network and co-working spaces[40].

The online platform economy blurs the difference between employer and employee. Online platforms acting as intermediaries between service users and providers share certain characteristics with the temporary work agency model. Service providers on online platforms are considered self-employed by the platform, even though the relationship between service providers and platforms often has features of an employment relationship, based on subordination. Platform work also challenges traditional collective organisation. This is a problem as many service providers do not develop a professional identity as platform workers and seem oblivious to the fact that solidarity with colleagues would be an option.

There are some examples of existing trade unions opening their membership to online platform workers. The ESDE (2018) mentions that IG Metall in Germany has so far taken the most systematic action in this regard by opening membership to platform workers in 2016. It has also engaged in a joint project called 'FairCrowdWork' with the Austrian Chamber of Labour, the Austrian Trade Union Confederation and the Swedish white-collar union 'Unionen'. This online tool collects information about online platform work from the perspective of workers and unions.

Some initiatives enable platform workers to set up semi-structured forms of cooperation. For example, initiatives have been set up to offer support for campaigns in specific workplaces or industries (like Coworker.org in the US for example). Grassroots movements have emerged in parallel, in which online platform workers can exchange information about potential clients (Online Filipino, Mturk). Such initiatives can be considered a first step towards developing of collective action for online platform workers.

Platform workers have set up a more permanent structure with the aid of traditional trade unions in Austria. The ESDE (2018) points out that Foodora couriers in Vienna founded what is probably the first works council of online platform workers. The establishment of the works council was facilitated by the Austrian transport and services trade union 'vida'. The main aim of the council is to negotiate better working conditions between couriers and management and to increase the number of employment contracts.

New technologies allow many employees (mostly what are called 'knowledge workers') to work from anywhere and at any time. In this regard, social dialogue is also important to make sure that employers and workers benefit securely from the increase in flexibility linked to telework. This flexibility can bring advantages but also a risk of additional stress: for example, it may make it more challenging to abide by rules on working time. Social

40 https://smartbe.be/fr/

partners therefore have a role to play in also managing the negative impacts of increased flexibility.

6.2. Managing labour legislation

As the World Bank (2018) points out, wage employment is still the most common basis for social protection. However, changes in the organisation of work caused by technology shift the financial burden of workers' benefits from employers to the State. These changes raise questions about the ongoing relevance of current labour legislation.

Labour legislation is mostly geared for working methods developed during the industrial era. As such, the coming age of AI and robotisation could have a significant impact on labour law. The present section tries to put forward some of the most noteworthy implications for labour legislation, with the important caveat that how EU labour law should be adapted would very much depend on the overall employment impact and uptake of automated technologies. As this report has indicated, this is neither straightforward nor set in stone. While the suggestions presented below are rather hypothetical given the uncertainties surrounding AI, what seems more certain is that how EU labour law needs to adapt would have to be part of broader discussions on the societal outcomes we want to achieve with the increased uptake of AI and robotics.

The goal of the present section is to examine how human working relationships, such as working time, employment conditions, health and safety at work, or minimum wages, will be affected by AI and robotisation. The report does not examine whether labour law should be enforced for robots. The answers to questions such as whether robots should be granted legal personality, the right to work a certain amount of hours per week, and afforded a paid vacation or sick leave, would be grounded much more in philosophy than labour law. As such, these questions are beyond the scope of this report.

6.2.1. Working time

In the past, productivity increases have been accompanied by a reduction in working time. This has so far not been the case in the latest wave of automation. Given the 'productivity paradox' discussed in Section 3.3, this is hardly surprising.

The present framework legislation dealing with working time is the EU's Working Time Directive. It requires EU countries to guarantee the following rights for all workers:

- a limit to weekly working hours, which must not exceed 48 hours on average, including any overtime;
- a minimum daily rest period of 11 consecutive hours in every 24 hours;
- a rest break during working hours if the worker is on duty for longer than 6 hours;

- a minimum weekly rest period of 24 uninterrupted hours for each seven-day period, in addition to the 11 hours' daily rest;
- paid annual leave of at least 4 weeks per year;
- extra protection for night work.

Whether and how this framework will need to be adapted to reflect the increased uptake of AI in the economy would depend on several factors. For example, an important consideration would be whether automation complements or replaces workers (the 'displacement vs augmentation' uncertainty discussed in previous chapters). If the current wave of automation results in more displacement of workers, this could result in either less people at work full-time or more people working full-time during a shorter working week. In either case, political choices will have to be made that go beyond purely adapting working time legislation to automation. Such choices would also include wider considerations of equity and wealth (re)distribution.

Automation could also lead to job augmentation, for example by increasing the use of collaborative robots in the economy alongside human workers. Paradoxically, increased robotisation in this scenario could also lead to increased working hours for some workers. As robots are not subject to working time regulations, machine supervisors could face longer working hours.

In both the displacement and augmentation scenarios, the current working time legislation would need to be monitored for any significant deviations from the rights enshrined in it. While the overall number of hours worked per week might need to be adjusted as part of wider societal considerations, the remaining working time rights should be observed and corrective action taken when new technologies infringe upon them.

Beyond purely mechanistic considerations of decreasing working time because of automation, there are also other implications to be taken into account. Worktime reduction also means an increase in labour costs, which may have negative consequences for the competitiveness of export-oriented firms if productivity does not increase accordingly.

6.2.2. Employment conditions

New types of self-employment (for example platform work) necessitate new employment regulations. As further elaborated in Section 6.4 below, self-employed people generally suffer from fundamental gaps in the core elements of social protection - i.e. against unemployment, sickness, accident and occupational injuries. If the current trend continues and more flexible and non-standard forms of employment continue to grow in importance (as would seem to be the case), policy would have to review the status of these types of employment and, if necessary, extend social security legislation to them.

The Commission took the first step in this direction when it launched its proposal for a Council recommendation on access to social protection for workers and the self-employed. The recommendation:

- closes formal coverage gaps by ensuring that workers and the self-employed in comparable conditions can join corresponding social security systems;
- offers workers and the self-employed adequate effective coverage, so that they can build up and claim adequate entitlements;
- facilitates the transfer of social security entitlements from one job to the next;
- provides workers and the self-employed with transparent information about their social security entitlements and obligations.

In December 2018, the Council agreed on its Recommendation on access to social protection for workers and the self-employed.

New types of non-standard work facilitated by the digital revolution could also undermine transparency and predictability of employment conditions for some workers. With this in mind, the Commission put forward its proposal for transparent and predictable working conditions. The proposal aims to ensure that certain rights cover all workers in all forms of work, including those in the most flexible non-standard and new forms of work such as zero-hour contracts, casual work, domestic work, voucher-based work or platform work. These rights include:

- more complete information on the essential aspects of the work, to be received by the worker, in writing, at the latest on the first day on the job (rather than up to 2 months afterwards);
- a limit to the length of probationary periods at the beginning of the job;
- the right to seek additional employment, with a ban on exclusivity clauses and limits on incompatibility clauses;
- the right to know a reasonable period in advance when work will take place, for workers with very variable working schedules determined by the employer, as in the case of on-demand work;
- the right to receive a written reply to a request to transfer to another more secure job;
- the right to receive cost-free the mandatory training that the employer has a duty to provide.

In February 2019, the Commission, Council and Parliament reached an agreement on the proposal on transparent and predictable working conditions.

The principles and rights laid down in the two Commission initiatives on access to social protection and on transparent and predictable working conditions should be the basis for any future adaptations of employment conditions legislation to AI and robotics. Given the voluntary nature of the Commission proposal on access to social protection, further work in this area would appear necessary.

The changes in employment conditions brought about by the digital revolution also have important implications for tax systems and the funding of social security contributions. This aspect is further examined in Section 6.3 below.

6.2.3. Health and safety at work

Up until recently, most of the robots used in manufacturing were room-sized, programmed machinery performing repetitive tasks. These robots were used for welding, assembly, material handling, and packaging. There are not many cases of harm caused by such large industrial robots, as the interaction between them and workers is limited. The increased use of collaborative robots (cobots), however, implies much more interaction and contact between human workers and machines. Cobots have much more autonomy and freedom to move about the factory floor. As such, there are important repercussions for occupational safety and health legislation.

International standards already exist for the safe manufacture and use of robots (such as ISO 10218 on Robots and robotic devices – Safety requirements for industrial robots, or ANSI/RIA R15.06-2012 for collaborative robots). While these regulate the safety requirements for machines, a very important consideration when it comes to occupational safety and health would be to prepare workers to work with machines. This would include educating the workforce what the capabilities and limitations of collaborative robots are, and how workers should react in unexpected scenarios when cobots are not functioning as expected. Such considerations would need to be part and parcel of any future review of occupations health and safety standards.

Further occupations health and safety concerns would also include increased workforce tracking (through wearable devices such as bracelets) for productivity purposes, which could increase stress and lead to work-related accidents. The possibility to track every step of employees also raises important privacy concerns and should be examined in a wider context of the appropriateness of workforce analytics. In addition, the limited access to social protection for some categories of workers described in the subsection above also extends to health and safety. This would need to be addressed as part of a wider reform of social protection for all workers.

6.2.4. Minimum wage

Whether and how minimum wage laws should be adapted to the age of AI is yet unclear. At present, 22 out of the 28 Member States have minimum wages in place – all but Austria, Denmark, Finland, Cyprus, Italy and Sweden. With the growing uptake of AI and automation in the economy, the case has been made for (introducing or) increasing minimum wages to countervail robotisation. This subsection briefly touches upon the major implications of using minimum wages as an instrument to address automation.

How minimum wages should react to automation would depend on the speed and scope of jobs displacement. If labour market disruptions are much more extreme than expected, then introducing or increasing minimum wages to cope with the societal repercussions could be considered advisable. These repercussions include growing inequalities and labour market polarisation, which are examined in depth elsewhere in this report.

On the other hand, if automation is more gradual, preventively adapting minimum wages could prove counterproductive. Common economic sense suggests that increasing the minimum wage puts more low-skilled jobs at risk of automation. Adjusting (or introducing) minimum wages would therefore seem more advisable as a reactive rather than proactive strategy to address automation.

Beyond the usual rhetoric of adjusting minimum wages in line with macroeconomic fundamentals, it would be for individual Member States to pick the most appropriate instrument to address the growing threat of inequalities in the age of AI. We cannot yet say how (or if) labour legislation on minimum wages would need to be adapted to the age of AI. What is certain, however, is that whether minimum wages could be the instrument mentioned above would depend on different national circumstances. Such discussions would need to be part of broader reflections on what kinds of societies we want to see emerging in the age of AI.

6.2.5. Further considerations

Beyond the labour law aspects examined above, the increased uptake of AI in the economy also has important implications for non-discrimination and gender equality. One particular area where labour law would have to be constantly monitored for infringements is hiring.

Algorithmic and data biases examined in Section 6.7 below would prove real challenges if and when automation technologies are more widely disseminated in recruitment processes. The current principles of non-discrimination already present an appropriate framework for the age of AI, which does not need to be adapted at this point. This means that discrimination is prohibited based on any ground such as sex, race, colour, ethnic or social origin, genetic features, language, religion or belief, political or any other opinion, membership of a national minority, property, birth, disability, age or sexual orientation. Rather, the way to address the threat of discrimination in recruitment would be through

ensuring algorithmic transparency and/or explainability, while the final hiring decisions would need to be kept in human hands to overcome the inherent flaws in the technologies. Labour legislation might need to be adapted to this effect.

AI also presents important gender equality challenges, which are touched upon in various sections of this report. These include higher risk of automation for certain jobs overwhelmingly performed by women, a growing gender pay gap in AI-related professions, and algorithmic and data biases resulting from under-representation of women among AI developers. A combination of legislative and non-legislative measures might be necessary to address challenges in these areas. The implications for gender equality should be monitored regularly. This could be done through the national observatories under the EU AI Systemic Risk Board proposed in Section 7.

6.3. Taxation in the age of AI

As already discussed in the report, the single most important step to help the workforce prepare for the coming age of AI will be to provide them with the necessary new skills to face labour market changes. As such, employers will have to invest heavily in the training of their employees. Despite continuous encouragement from the Commission to lower labour taxation, it remains very high in some Member States. This creates obstacles to new hiring. On the contrary, a more balanced tax regime also focusing on wealth, property, physical assets or environmentally unfriendly activities, could prove beneficial for job creation. It could also help make taxation fairer. In addition, the current focus on labour taxation does not encourage employers to invest in their workers and dedicated measures to address this will be necessary. One such measure would be to provide tax incentives for investment in human capital. Such incentives could cover, among others, training and education expenditures.

The OECD (2017) mentions that tax systems affect the ability of individuals to develop skills in various ways. The revenues that taxes raise can be used to finance direct investments in skills. The Fiscal Code can treat labour and capital income differently. This can create incentives to invest in physical instead of human capital. The tax system can also affect the financial incentives of individuals to develop, activate and use their skills efficiently in the labour market. The OECD (2017) further specifies that better skill levels lead to higher wages and stronger employment prospects for workers, higher productivity and profits for businesses, and higher growth rates and tax revenues for governments.

Most EU tax systems do not necessarily treat human capital and R&D investment equally when it comes to employer incentives to invest. Costa et al. (2018) point out that this is the case, for example, in the UK, where companies investing in R&D can claim generous tax relief on their investments but do not have the same incentives when it comes to training their employees. This is unfortunate, as further training of the workforce leads to positive

effects for the economy, since highly skilled workers are more productive in their jobs irrespective of the employer.

Costa et al. (2018) further specify that the Austrian tax system is a good example of incentivising companies to invest in human capital. This includes a full tax allowance for training expenses, while a further 20 % of actual expenses is deducted from taxable income, implying a 120 % tax allowance in real terms. The biggest risk of introducing such schemes is that employees might move before the employer has reaped the benefits of investing in their training. Costa et al. (2018) suggest that such a risk could be decreased by compensating the company for the potential loss of their investment when an employee decides to leave. This could be done by providing tax credits/allowances for unsuccessful or unrealised investment.

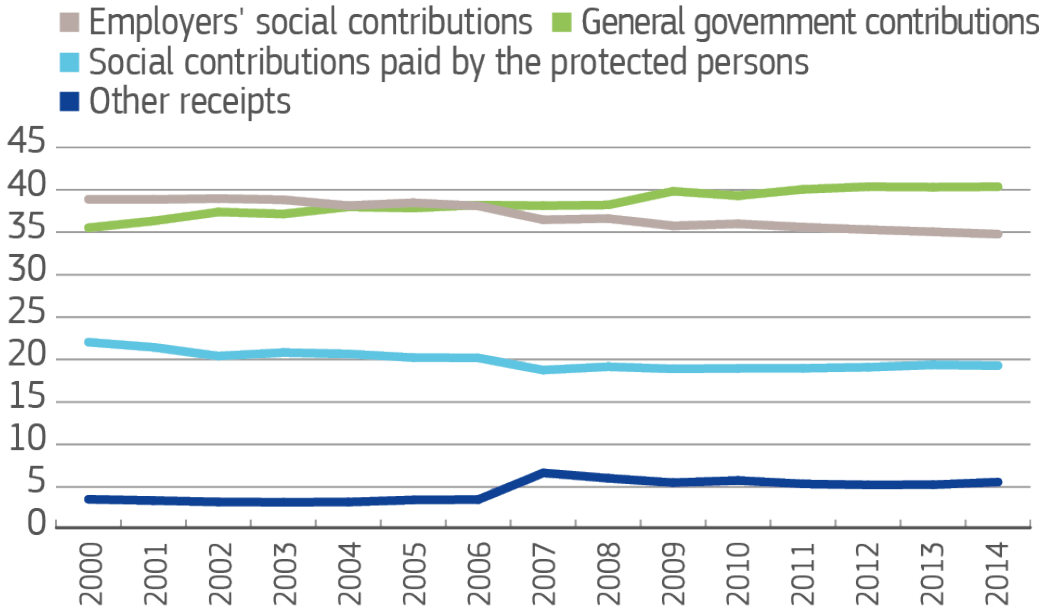
Looking at the overall composition of social protection financing, it is interesting to note that increased reliance on general government revenues accompanied the overall growth of social protection receipts in 2006-2015. In most Member States, the largest source of this growth in social protection financing was general government contributions, which grew from around 10 % of GDP in 2000-2006 to over 12 % by 2012. Social contribution receipts grew overall, but at a slower pace[41].

Consequently, the relative weight of social contributions has gradually declined, with general government revenues providing a growing proportion. The ESDE (2018) points out that employers' contributions, which typically represent the largest proportion of contributions, have declined most strongly (see Graph 18). However, the contributions by protected persons (employees, to a lesser extent the self-employed, pensioners) have also tended to decline relative to funds contributed by general government.

41 ESDE 2018

Graph 18: The proportion of general government contributions in social protection financing increases

Social protection receipts by type (total =100), EU25



Source: ESDE 2018

Furthermore, the prevalence of non-standard forms of work is likely to put additional pressure on the financing of social protection in the future. Certain new forms of work blur the distinction between employees and the self-employed. As a result, non-standard workers' contribution levels are on a par with those of the self-employed. The self-employed typically pay lower contributions than employees.

The changing nature of work challenges labour taxation and reinforces the need for a tax shift away from labour. The ESDE (2018) points out that with the emergence of new non-standard forms of work, certain administrative advantages of taxing labour income are fading. Under existing tax administration methods, labour income becomes less traceable for workers who have several employers, often earning smaller amounts per individual contract. Their employment status also becomes more difficult to verify. Unlike with employers with reporting obligations, third-party reporting is harder to enforce, as both the users of labour as a service and the intermediaries are difficult to pin down.

Further sources of financing will probably become necessary as the contributory base diminishes. One solution could be to raise contribution rates. This might not be practical, however, as many Member States' levels of labour tax burden could already be harming competitiveness and warranting cuts in contributions or taxes. New sources of funding may need to be found.

One particular suggestion on how to deal with an eroding tax base in the age of AI and robotisation is to introduce a so-called 'robot tax'. This could essentially entail taxing robots at a similar rate to what a worker would have been taxed if he had not been replaced by automation. Such proceeds could be used to fund the labour market transitions stemming from AI and automation. Traditional arguments for introducing of such a tax include that it could slow down the deployment of automation if job losses prove much more dramatic than expected, and could raise money to keep government programmes running. People arguing against such a tax say that it is not really needed, as the impact on job markets will not be dramatic. Implementing such a tax could also prove very hard, and it could backfire if adopted in only some jurisdictions, leading to an exodus of robotics companies and the stifling of innovation. An alternative to a robot tax could be the shared ownership of robots, where governments buy and own robots, which they then rent out and share the rental income with the individuals most affected by automation.

Looking more generally at the impact of AI and digitalisation on tax bases, we can see that current tax rules were not designed to address a situation where companies are global, virtual or have little or no physical presence. Nowadays, 9 of the world's top 20 companies by market capitalisation are digital, compared to 1 in 20 some 10 years ago. There is a growing necessity to ensure that digital companies also contribute their fair share of tax. Otherwise, there is a real risk to Member State public revenues, as digital companies currently have an average effective tax rate half that of the traditional economy in the EU[42].

In this light, in March 2018 the Commission proposed two distinct initiatives to ensure that digital business activities are taxed in a fair and growth-friendly way in the EU. Following significant opposition by some Member States[43], the idea for an interim tax on digital companies' revenues was abandoned and replaced by a Franco-German proposal for a temporary levy of 3 % on digital companies' advertising activities. The proposal was expected to come in force in 2021 for a period of 4 years, but even this watered down plan has met with resistance in the Council and is set to be abandoned[44]. Given the difficulties to find a common approach, France has announced its own plans for a digital tax as of 1 January 2019[45]. This is a less ambitious approach, which does not necessarily address the need for a comprehensive solution to fair taxation of digital companies. The United Kingdom, on the other hand, has already announced a 2 % levy on revenues from the activities of UK users of search engines, social media platforms and online marketplaces, to be applied as of 2020[46]. It is important that reforms making tax rules more compatible with digitalisation are part of a more concerted global discussion to avoid distortions in

42 https://ec.europa.eu/taxation_customs/business/company-tax/fair-taxation-digital-economy_en
43 https://www.politico.eu/pro/council-eu-countries-cannot-accept-digital-tax-for-political-reasons/. Last accessed on 20 March 2019.
44 https://www.reuters.com/article/us-eu-tax-digital/eu-states-set-to-scrap-digital-tax-plan-to-work-for-global-reform-idUSKCN1QN1WF. Last accessed on 20 March 2019.
45 https://www.euractiv.com/section/digital/news/france-to-go-it-alone-on-digital-tax-plans/. Last accessed on 20 March 2019.
46 https://www.politico.eu/article/uk-to-bring-in-digital-services-tax-in-2020/. Last accessed on 20 March 2019.

international tax competition. The recent agreement reached by the OECD to reach by 2020 a multilateral long-term solution to the taxation challenges arising from digitalisation is a welcome development in this regard. Given that taxation is a national prerogative and all EU actions in this regard need unanimity to go ahead, one possible way to advance reforms in the EU is through enhanced cooperation or a separate intergovernmental treaty (as in the case of the European Stability Mechanism).

While there certainly is a need for a fairer tax regime when it comes to digital companies, this should not be at the expense of incentives to innovate. If public regulations limit innovation, employment is more likely to decrease. An improved tax regime should also be more conducive to supporting AI development in Europe, with all the accompanying economic benefits this entails. For example, the Canadian government has been investing significantly in R&D, based on the mindset that it is impossible to predict where the next big innovation will come from. As a result, Canada has bet on a broad-based technology investment strategy that favours making many small sector-agnostic investments. This philosophy to support R&D is also written into Canadian tax laws, which offer generous tax credits, which are ranked by the OECD in the top five worldwide.

6.4. Ensuring adequate social protection

Labour markets are becoming more fluid, with people increasingly taking part in self-employment and multiparty-employment arrangements. Social protection systems structured around long-term employer-employee relationships are increasingly disconnected from these trends. Addressing these societal transformations and making social protection adequate for all types of work are becoming increasingly important.

Technological change and globalisation create new opportunities, but also call for modernising welfare systems and the provision of public goods and services. As the ESDE (2018) discusses, technological innovations and global information flows have created employment opportunities that would have been difficult to imagine even two generations ago. At the same time, these developments create new needs, such as access to digital communications. Moreover, welfare systems that are adapted to traditional labour markets may be suboptimal in the context of more diverse employment relations and frequent career changes.

Many social protection systems were designed assuming a stable contractual employment. Changes in the labour market, which make workers' careers less predictable (with more frequent breaks and changes of job and occupation) and incomes more volatile pose significant challenges to social protection systems.

Some forms of non-standard employment blur the line between being in and out of work. A part-time employee who would prefer to have a full-time job could be considered as partially unemployed. Some Member States already have specific unemployment insurance

arrangements for such workers. Very short-term assignments mediated by online platforms could raise further questions about employment status.

The ESDE (2018) points out that non-standard work is highly diverse and implications for social protection differ according to employment status. Key characteristics of the standard employment relationship include: (i) a bilateral relationship between worker and employer; (ii) personal subordination of the employee; (iii) economic dependency, involving an open-ended cooperation; and (iv) full-time working, with corresponding social security contributions paid by the employer and employee. Forms of work deviating from this standard generally receive less protection from social security. Specific groups of workers are thus systematically at a disadvantage as regards social protection.

One aspect of social protection that is becoming increasingly important is transferability of rights. This applies, for example, to the pension entitlements of someone who has worked as an employee but who then becomes self-employed. It may also affect the rights of workers changing to different sectors. Portability of social protection entitlements is essential if modern welfare systems are to support dynamic labour markets and job transitions.

The ESDE (2018) further mentions that in certain Member States, specific categories of non-standard workers are not formally covered for certain risks (see Graph 19). Formal social security coverage is usually the same for employees in non-standard employment and for those in standard employment. There are exceptions, however: most notably, casual and seasonal workers, apprentices or trainees, on-demand workers and those on temporary agency contracts, as well as people working on certain types of contracts defined at the national level. Such coverage gaps are widespread geographically, as the graph below suggests.

Graph 19: Specific groups of non-standard workers cannot access the social security schemes of certain Member States

Lack of formal social security coverage for non-standard workers

	Casual workers	Seasonal workers	National specificities	Freelance	Apprentices	Trainees	Vocational trainees
Unemployment benefits	RO, HU, MT, LT	BG, RO, LV, HU, MT, LT	AT[a], CZ[b], DE[c], PL[d], SK[e]		BE, EL, HR, MT, NL, PL	EL, FR, IT, LT, MT, NL, PL, RO	
Sickness benefit	HU, LT, LV, RO	HU, LT, LV, RO	CZ[b], SI[d]		BE, HU, NL, PL	DK, FR, HU, LT, NL, PL	DK, EL, FR, HU, PL
Maternity benefit	LT, RO	BG, LT, LV, RO	CZ[b], PL[d], Uk[h]	BG, FR	BE, MT	FR, HU, IT, LT	EL, FR, HU, IT
Accident and occupational injuries	RO, HR, LT	BG, LT, LV, RO	CZ[b], ES[f]		BE, HR, MT	EL, FR, HU, IT, LT, MT	
Old age/survivors' pensions	MT, LT	BG, HU, RO, LT	CZ[b], HU[g], LU[g], MT[h], PL[d]				
Invalidity	HU, LT	HU, LT	AT[a], PL[d]				

Notes: The table reports in which branches and in which Member States non-standard workers are excluded from formal coverage in the sense that they have no mandatory coverage and cannot opt -into voluntary schemes.
Source: ESDE 2018

It is very important to stress that formal coverage tends to be critical for the self-employed. There are fundamental gaps in three core elements of social protection (i.e. protection against unemployment, sickness, accident and occupational injuries), where the self-employed as a group are excluded from membership in some Member States, as they cannot join the scheme. Certain categories of self-employed workers do not have any formal access to unemployment benefits in a substantial number of Member States.

Case study: Singapore SkillsFuture Credits

SkillsFuture Credit aims to encourage individual ownership of skills development and lifelong learning. All Singaporeans aged 25 and above receive an opening credit of USD 500 as of January 2016. The credit does not expire and the Singaporean Government will provide periodic top-ups so that credit can accumulate.

Currently, employers are eligible for subsidies ranging from up to 50 % to 90 % of course fees for supported courses. Under the enhanced training support scheme for SMEs, SMEs receive a course fee subsidy of up to 90 % when they sponsor their employees for training. Under the workfare training support (WTS) scheme, both SMEs and non-SMEs who sponsor WTS-eligible employees can receive a 95 % course fee subsidy. Employers who sponsor their workers aged 40 and above can also receive a course fee subsidy of up to 90 %. Employers are strongly encouraged to use these assistance schemes specially designed for them. In addition to course fee subsidies, sponsoring employers will also receive absentee payroll support.

Employees who are sponsored by their employers to go for training do not have to use up their own SkillsFuture Credit to pay for course fees, as their course fees are paid by their employers.

The government will make periodic top-ups to Singaporeans' SkillsFuture Credit accounts. No decision has been made yet on the timing and amount for the next top-up. SkillsFuture Credit is not a cash account and does not earn any interest.

Source: https://www.myskillsfuture.sg/content/portal/en/header/faqs/skillsfuture-credit.html

6.5. Addressing inequality and making AI accessible and understandable to all

To promote social acceptance of new technologies, policymakers need to tackle the real and perceived threats associated with AI. There is a strong psychological element of fear in Europe about AI, which could undermine or derail its uptake. Such fear is absent in some other cultures, such as China for example, and this could have strategic economic implications unless tackled. To overcome this element of fear, improving people's

understanding of, accessibility to and trust in AI technologies will be paramount. Addressing this would tackle the rising threat of inequalities inherent in the new technologies. Better understanding of technology would also improve its take-up.

A precondition for tackling the psychological element in people's perceptions of AI is the reliability and safety of such systems. If people are not able to trust these systems, they will not contribute to their development and use. To make sure AI is safe and reliable, Microsoft (2018) recommends that the data and models used to train and operate AI-based services and products are checked and evaluated systematically, and that information about possible inadequacies in the training data is shared on a regular basis. To understand ongoing performance monitoring, it is very important to put in place processes for documenting and auditing AI systems.

Microsoft (2018) also underlines that when AI systems make important decisions about people, the overall systems operation needs to be adequately explained, including algorithms, training data and any eventual failures that might have occurred during training. The involvement of experts in the field when decisions taken by AI systems have an important bearing on people is another key deliverable of more trustworthy AI. Finally, provision needs to be made for AI systems to seek human input during critical situations, while feedback mechanisms need to be developed to report any performance issues that a user might have encountered.

Societal trust in new technologies will also reflect upon the uptake of these technologies. Consumers will trust and use these technologies if they are considered safe and if the associated legal framework is clear and effective in providing potential remedies. As such, the liability framework currently in place will need to be reviewed from the point of view of both consumers and companies. Ensuring equitable legal remedies, compensation and allocation of responsibility will be important to win people's trust. These will also be important for innovators and businesses operating in the EU, as legal certainty will be a key part of technological and business development[47]. The Commission has already started the review of the liability framework in the EU and a report on potential gaps is expected in mid-2019.

To improve social understanding, people also need to be aware that they are interacting with an automated system. Recent examples of deceptive commercial and political practices on social platforms have undermined people's trust in AI and have resulted in calls for actions to remedy this behaviour. Some legislatures are already taking action, for example in California, where from 1 July 2019, companies will be obliged to disclose that they are using chatbots to communicate with the public on the internet[48].

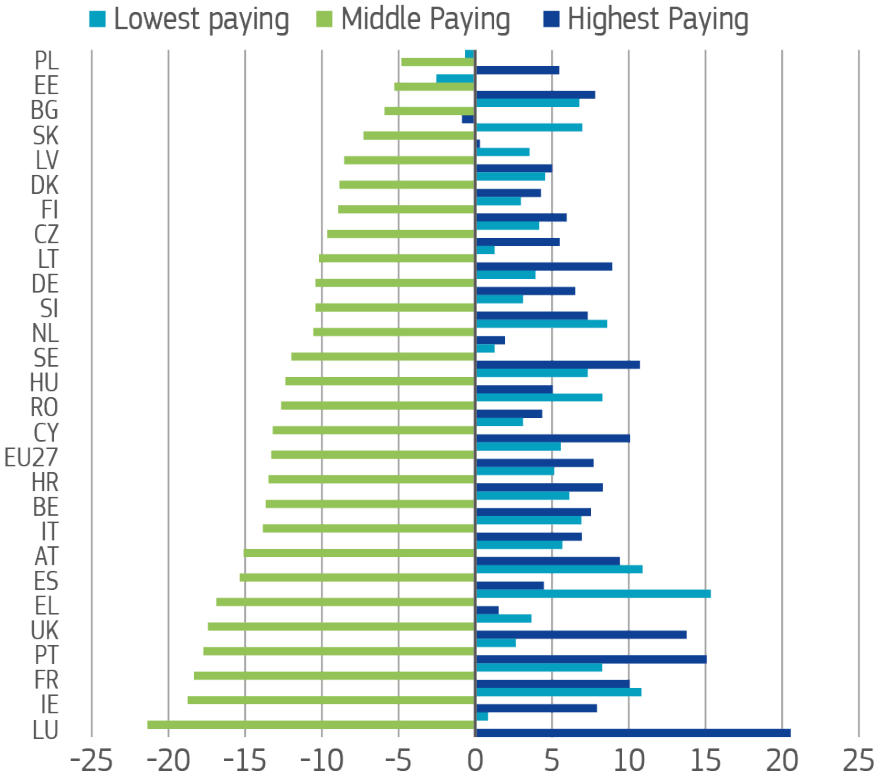
47 For more on this, see Liability for Emerging Digital Technologies, Commission Staff Working Document. Available at https://ec.europa.eu/digital-single-market/en/news/european-commission-staff-working-document-liability-emerging-digital-technologies. Last accessed on 20 March 2019.
48 https://qz.com/1409350/a-new-law-means-californias-bots-have-to-disclose-theyre-not-human/. Last accessed on 20 March 2019.

Unless mitigating actions are taken, the increased uptake of AI can increase existing inequalities within societies and further reinforce the divide between rich and poor. As already discussed, many of the jobs that will be replaced by AI include routine and repetitive tasks, which in most cases are overwhelmingly employing lower-skilled workers. In addition, the gap between lower- and higher-skilled individuals may be further exacerbated by the increased importance of soft skills and critical thinking, as such skills are much more likely to be possessed by the latter set of people. Retraining for new jobs will be increasingly important and higher-skilled workers are both more willing and more able to afford it. The increased automation of labour can also undermine public finances and increase the share of capital in total gross value added (see Graph 17), which could undermine the welfare state and further enhance the gap between rich and poor.

The increased uptake of AI and robotisation could thus bring about further polarisation - there is already a divide between highly skilled and low-skilled workers. This divide is on the increase, and is compounding inequalities in the workforce (see Graph 20). Some disappearing low- or medium-skilled professions will be replaced by high-skilled ones; but can we say that all those truck drivers whose jobs are set to disappear will become IT engineers or creative designers?

Graph 20: The proportion of middle wage workers is shrinking everywhere

High, middle and low-paying jobs in the EU - change from 2002 to 2016 in pps.

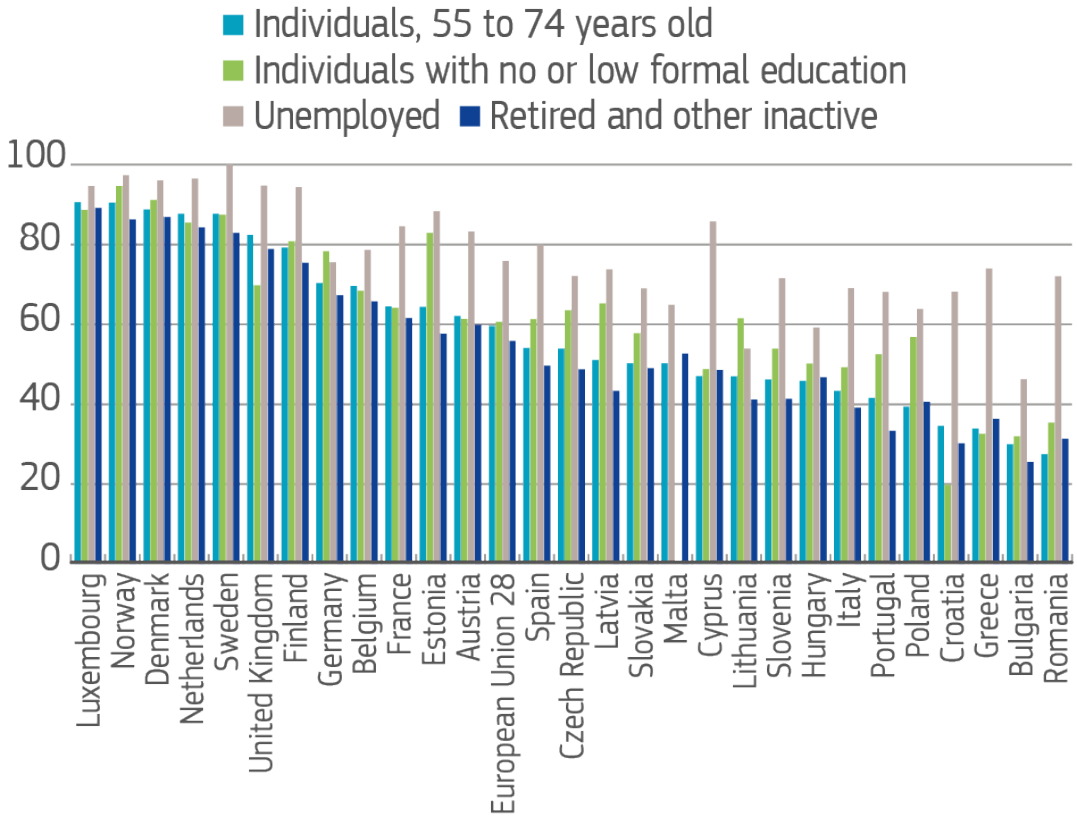


Source: ESDE 2018

Income support and other types of transition assistance to help displaced workers find employment will be very important. McKinsey (2017b) points out that apart from retraining, something else that could be very helpful would be a set of policies such as unemployment insurance, public assistance in finding work and portable benefits that follow workers between jobs.

Ensuring access to AI for everyone is hampered by the share of people without basic literacy, numeracy and digital skills. In 2017, 43 % of Europeans still had insufficient basic digital skills, while 17 % had none at all and 13 % had never gone online (see Graph 22). The digital exclusion risks were particularly high for people with low educational levels, on low incomes, as well as the elderly, the retired and the inactive (see Graph 21)[49].

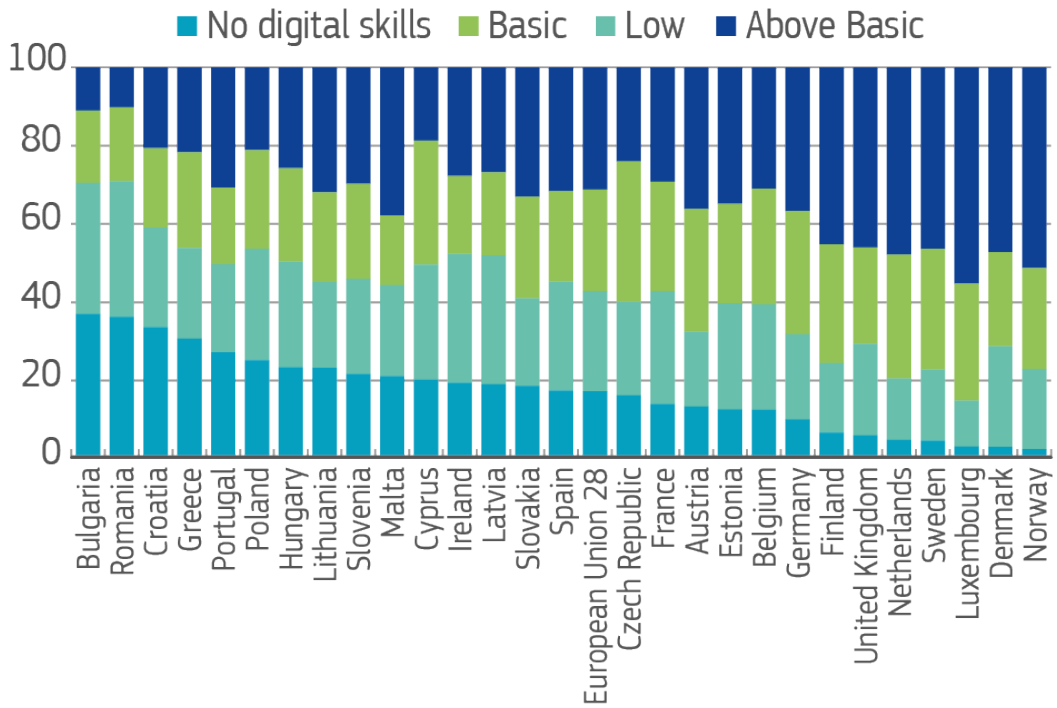
Graph 21: % Individuals who are regular internet users in 2017, different vulnerable categories



European Commission, Digital Scoreboard

49 The Digital Economy and Society Index. https://ec.europa.eu/digital-single-market/en/human-capital

Graph 22: Digital Skills Indicator (all individuals)



European Commission, Digital Scoreboard

Gender, ethnic and socioeconomic diversity are important for a variety of reasons. As further elaborated in the House of Lords (2018) report, careers in AI are well remunerated and are an area of rapid growth, while the dominance of these positions by already privileged groups in society is likely to exacerbate existing inequalities further. This lack of diversity also has a significant impact on the way that AI systems are designed and developed. If we are to ensure that these systems, which are exerting growing influence over our lives and societies, serve us fairly rather than perpetuate and exacerbate prejudice and inequality, it is important to ensure that all groups in society are participating in their development.

AI-powered products can also increase inclusiveness and bring new opportunities to people excluded from the labour market and society. For example, in the summer of 2017, Microsoft launched an app designed to help blind and partially sighted people better navigate the world. The app, Seeing AI, uses 'computer vision' to narrate the user's surroundings, read text, describe scenes and even identify friends' facial cues. It uses neural networks, similar to the technology found in self-driving cars, to identify its environment and speak its observations aloud[50]. Morpx Inc., a Chinese-based start-up, is developing educational robots that children can assemble and programme themselves. This is an important factor in teaching children to live with robots and in improving social understanding of the new technologies.

50 https://www.engadget.com/2017/07/12/microsoft-app-blind-see-ai-seeingai/. Last accessed on 20 March 2019

A good example of civil society engagement in the development of AI comes from Quebec, Canada. The region utilises co-creation seminars to let citizens shape AI policies. Co-creation is a form of open policymaking where those implicated by the outcome are directly involved in its creation. During the co-creation seminars, citizens were put in a room for a day and asked about their views on AI. This is a useful approach that contributes towards societal understanding and acceptance of the technology. This, in turn, is paramount for making the AI revolution work for everyone in society.

6.6. Universal basic income

The EPSC (2018a) points out that in a world where work may be neither guaranteed nor able to cover basic human needs, many argue that a universal basic income (UBI) may be not so much a distant utopia as a baseline necessity. The idea of providing all citizens with an unconditional stipend robust enough to maintain a dignified life is not new, having been proposed as early as 1797 by Thomas Paine. Many UBI pilot projects have been rolled out around the world in recent years. Preliminary outcomes underline the importance of the details: unambitious stipends that merely streamline existing benefits while being insufficient to maintain living standards end up subsidising low-paid jobs. More generous experiments, which are currently being designed, continue to explore whether people who receive an UBI take up study, creative endeavours, or even entrepreneurial ventures, as well as what the costs and benefits may be.

At the beginning of 2017, Finland launched an experiment on basic income, which lasted until the end of 2018. The target group was composed of 2 000 people between 25 and 58 years old, all of whom were recipients of the basic unemployment benefit. For 2 years, they were paid EUR 560 per month, equal to the basic unemployment insurance. There was no means testing and recipients could work without losing the benefit. While results from the first year of the experiment will be released in spring 2019 and the final report in 2020, preliminary findings suggest that employment levels did not improve, but participants felt happier and less stressed[51].

Implementing UBI schemes is touted as the answer to job losses due to automation, even if we disregard the obvious issue of how expensive such a scheme would be. However, this position neglects one key element – the intrinsic value of work. Work is instrumental to people's sense of identity and belonging. Most people are wired to want to create, contribute and provide for themselves rather than rely on support from the State. This means that a UBI scheme would not be a viable replacement to jobs lost because of automation.

51 https://www.bbc.com/news/world-europe-47169549. Last accessed on 20 March 2019.

6.7. Further considerations

There is a growing anxiety across different parts of societies in European countries about the negative impact of the digital transformation. In some companies, there is a clear reluctance, even from management, to introduce artificial intelligence solutions based on the unfounded fear of the job losses that they may trigger. The ongoing debate on the future of work is a case in point. Some are even arguing (with some scientific underpinning) that work will eventually disappear and are considering options to keep humans occupied. Beyond the debate on the future of work, there is growing anxiety about some social implications of artificial intelligence, such as possible intrusions into privacy, the risks of discrimination and exclusion, which could be bigger when using AI. There is clearly a need to improve digital understanding and data literacy across society, as these are the foundations upon which knowledge about AI is built.

The development of understandable AI systems is a fundamental necessity if AI is to become an integral and trusted tool in our society. This could take the form of technical transparency, explainability, or both. This is essential for citizens and consumers to understand and trust AI. Some actions have already been taken to address this, for example under the GDPR, which puts in place provisions for explainability and transparency of algorithmic decision-making in the field of data privacy.

The current generation of AI systems, which have machine learning at their core, need to be taught how to spot patterns in data; this is normally done by feeding them large bodies of data, commonly known as training datasets. The House of Lords (2018) report on AI points out that these systems are designed to spot patterns, and if the data are unrepresentative, or the patterns reflect historical patterns of prejudice, then the decisions which they make may be unrepresentative or discriminatory as well. This can present problems when these systems are relied upon to make real-world decisions. This is commonly known as 'bias'.

Researchers and developers face several challenges in tackling bias: (i) ensuring that data used to feed into algorithms are pre-processed to make certain they are balanced and representative wherever possible; (ii) having developer teams that are diverse and representative of wider society; and (iii) engaging all parts of society in the production of data. Alongside questions of data bias, there are also issues of bias embedded in the algorithms themselves: as human developers set the parameters for machine learning algorithms, the choices they make will intrinsically reflect the developers' beliefs, assumptions and prejudices. The main ways to address these kinds of bias are to ensure that developers are drawn from diverse gender, ethnic and socioeconomic backgrounds.

There are already examples of good practices to find and address algorithmic bias. In May 2018, New York City announced the creation of a task force to examine city agencies' use of algorithms for decision-making purposes. The task force was mandated by a City Council Law in 2017 as part of a broader effort to study how AI systems discriminate against people based on race, gender, sexual orientation and citizenship status[52]. More concretely, the newly established task force will examine the use of machine learning systems used in the police department, the department of transport, the justice system, the department of

[52] https://venturebeat.com/2018/05/16/new-york-city-announces-task-force-to-find-biases-in-algorithms/. Last accessed on 20 March 2019.

education and the department of social services. The task force is to establish a process for determining whether automated systems are fair, equitable and accountable. The final output of the task force will be a report, to be ready in December 2019, which will identify ways the algorithms' decision-making can be made more transparent. As automated decision-making is likely to gain traction with the increased uptake of AI, algorithmic auditing will be an increasingly important part of diagnosing and correcting the unwanted consequences of such automated systems.

Case study: Workforce analytics

AI and big data can seriously aggravate power asymmetries and biases in the workplace. New technologies may lead to unexpected or unknown workplace dynamics and, combined with unintentional AI-facilitated discrimination, could challenge the foundations of our societies. 'Workforce analytics' are already emerging as a way to screen employees through AI; preliminary research shows that the data and algorithms used are rarely neutral. Outcomes often replicate the same bias that society has been trying to eradicate with anti-discrimination laws for decades.

In the workplace, new surveillance capabilities are being adopted by companies that allow management to oversee, monitor and assess the work of their employees constantly and potentially invasively. For example, Amazon has been granted patents for a wristband that can pinpoint its employees' location and track their movement in real time. If deployed, such a device could improve the efficiency of warehouse workers but also be used to prepare a detailed second-by-second report of the performance of each employee.

Source: EPSC 2018a

Workforce analytics can also potentially be used in a more positive way. For example, AI technologies help IBM to find the training relevant for underperforming staff. This increases transparency on where employees stand and where their future lies, and it gives the employees choices and opportunities. For example, a job-to-job transitions experiment at the beginning of 2017 almost eliminated paid separations from IBM's agenda. Instead of simply firing the underperformers, IBM tried to identify why people were not successful and offered them a serious of options – such as work with external coaches to place people internally within the organisation and also externally. This resulted in 3 500 people in Europe (out of 80 000 employees in Europe) improving their performance and getting back on track. It also saved the company about USD 450 million that would otherwise have been spent on redundancy programmes; instead the money could be used for job-to-job transitions and for other investments. IBM considers that the use of AI to better identify employees that are on-track or off-track helps them to move people at the speed the organisation is moving. Being more transparent about performance gives employees the time, choice and opportunity to adapt.

Case study: Avoiding sampling bias in research

When looking for ways to address data and algorithmic bias, inspiration can be drawn from how researchers avoid sampling bias. Sampling bias refers to errors that occur in research studies when the researchers do not properly select their participants. Ideally, people participating in a research study should be chosen randomly while still adhering to the criteria of the study. When researchers fail to select their participants at random, they run the risk of severely affecting the validity of their results and findings because their sample does not accurately reflect the population of interest.

Sampling bias is very common in research. One of the most well-known examples of sampling bias occurred during the Truman-Dewey United States presidential race of 1948.
During the race, a political telephone survey was conducted nationwide. The results of the survey implied that Dewey would win over Truman in a landslide. However, the study failed to account for the fact that telephones were still a fairly revolutionary and expensive form of technology.

Due to the cost of telephones in 1948, only a small number of wealthy families owned them and kept them in their homes. Therefore, the political telephone survey was only presented to participants that were part of relatively wealthy families, who at the time tended to support Dewey, while lower-middle class to lower class families were more likely to support Truman.

One of the methods to avoid sampling bias is stratified random sampling. Stratified random sampling allows researchers to examine the population that they will be working with in their study, and comprise an accurately representative sample accordingly.
For example, stratified random sampling is effective if there are 1 000 individuals in a population and 10 people from that population are required to conduct a study. If 500 members of the population are women and 500 members of the population are men, then the researchers' sample should accurately reflect this. This means that the sample must be comprised of five women and five men.

Stratified random sampling enables researchers to become aware of this information prior to building their sample, which means they can avoid sampling bias. This approach can be applied to the problems with data and algorithmic bias. It shows the importance of constructing diverse developer teams and pre-processing training data to make it balanced and representative of the larger society.

Source: How to Avoid Sampling Bias in Research.
https://www.surveygizmo.com/resources/blog/how-to-avoid-sampling-bias-in-research/

Box 6: Ethical principles for AI

Given the speed and scope of potential societal changes brought about by the increased uptake of AI, creating an ethical framework for the development of the technology is even more pressing. This framework needs to (i) broadly respond to what the role of AI in society should be and how AI will avoid creating or reinforcing unfair bias; (ii) address safety and accountability concerns related to AI; (iii) ensure the protection of personal privacy and dignity; (iv) help prepare people for the future of work; and (v) lay the groundwork for the promotion of AI as a tool that fights existing inequalities in our societies rather than reinforcing them.

Work on putting together an AI ethical framework has already started at EU level. The Commission has appointed 52 experts to a high-level expert group on artificial intelligence, comprising representatives from academia, civil society and industry. One of the tasks of the high-level group is to propose AI ethics guidelines to the Commission. The guidelines will cover issues such as fairness, safety, transparency, the future of work, democracy and, more broadly, the impact on the application of the Charter of Fundamental Rights, including privacy and personal data protection, dignity, consumer protection and non-discrimination. The draft AI ethics guidelines were presented in December 2018 and the final version is expected in spring 2019.

CHAPTER 7

RECOMMENDATIONS

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What can the EU, Member States, social partners, businesses and workers do to better manage societal transformations in the age of artificial intelligence? Having looked at the effects of AI and robotisation on labour markets in Europe, there are seven key areas in which recommendations can be made. These are: education and talent management, building AI capacity in Europe, work organisation, support for entrepreneurship and SMEs, improving societal understanding of the digital and AI transformations, issuing a mission statement for AI development in Europe, and ensuring appropriate funding for managing transitions.

7.1. On education and talent management

The impact of automation on jobs implies the transformation of tasks that form a specific job. We are already witnessing some of these transformations. Further transformations that will affect jobs in the coming years are hard to predict. Education is a long-term investment in knowledge, and is based on current labour market and societal needs. Scientific studies show that, by the time a student graduates from university, a substantial part of the subjects they have learned in the first year have started to become obsolete. Most students receive information and knowledge about the world as we know it today, not

about what they need to do to successfully manage career transitions in case of radical changes. In fact, a very high proportion of children starting school today will have jobs that do not currently exist.

7.1.1. Secondary education: learning how to learn

> Imagine yourself back in secondary school, trying to decide how to continue your education. What kind of job do you want to have when you graduate? How do you get the skills necessary for this job? What happens if this job disappears because of technological change? How do you find the answers to all these questions? Either you can be lucky enough to own a crystal ball or you can choose to invest in skills that will be important irrespective of labour market fluctuations. However, what are these skills?

The changes, which AI and automation bring about, are still unfolding and we are not yet certain what is coming our way. No matter how the AI revolution plays out, students will need more flexibility and resilience – they will need to learn how to learn. The following four elements are essential to ensuring that students have the resilience necessary to adapt their skills to future jobs, occupations and organisations - ones that are very different from those on the market today and mostly unknown:

1. All young people must acquire a sufficient proficiency level in basic skills, i.e. literacy, numeracy and digital skills. It is not acceptable that there are currently 61 million Europeans (the size of the entire population of one of our largest Member States!) who do not have these basic skills: without them, people become unemployable. Looking at the EU's Programme for International Student Assessment scores, the picture is not reassuring: some of our Member States are seriously lagging behind and this will be a major stumbling block to their economic development.

2. Member States need to review and modify secondary school curricula so that they focus on skills that are transferable across jobs. These include general cognitive skills (the capacity to understand an increasingly uncertain environment), critical thinking, problem solving, reasoning, mathematics, logic and communication. This should have a strong focus on adaptability, the capacity to respond to unexpected circumstances, and the capacity to learn new skills autonomously and quickly. All schools should provide their students with a guarantee and a minimum threshold of transferable cognitive skills.

   In addition, a new subject should be added. It could broadly be called computer science, but would include more than just coding, also looking at topics such as networks, algorithm development and data science. The time allocated to this

subject in the curriculum should be equivalent to the time spent teaching physics, maths or biology, and it should be taught over several years. The introduction of such a subject could also help address gender biases in algorithm development.

3. The organisation of secondary education systems needs to put more focus on skills combination and give students more flexibility to combine technical and general subjects in their studies, so that they eventually have the capacity to blend science, technology, engineering and mathematics skills with traditional subjects, such as business operations for instance. This holds true both for VET and general schools - there should be real bridges and flexibility between general and technical tracks.

4. The process of matching labour market demand and supply should be reimagined by transforming the job application stage – job requirements should be reformed, so that employers and public employment services list the skills required for jobs instead of degrees/diplomas that applicants should have. This should also encourage applications from people with diverse skillsets.

Member States, the European Commission and companies all have a role to play in making sure that the secondary education system equips students with the necessary skills to adapt to changes brought about by AI. Member States are responsible for reforming school curricula, while companies should be involved in promoting and reforming apprenticeship schemes and work-based learning. The Commission can support the process by sharing good practices and investing in the reform process through the European Structural and Investment Funds.

7.1.2. Adult education

> Imagine yourself in the middle of your career. You have been working in your field for a long time but now want to change (or have to, as an annoying robot has all but virtually replaced you at work). You need new skills but you do not want to (or cannot) get them from the existing educational institutions. Where do you go? How do you continue your education as an adult?

Lifelong learning has long been recognised as an important element of ensuring that people are employable beyond their current position: it is of clear benefit to both companies and workers.

However, in practice, lifelong learning does not work as well as it could and is not adapted to the challenges of the fast-changing world of work. Statistics show that those who benefit from lifelong learning are often those who need it least (highly skilled workers), whereas vulnerable workers tend not to have access to it. Furthermore, employers tend not to anticipate and systemically prepare their workers for major skills adaptations; when

workers lack the skills needed, the tendency is to make them redundant and recruit new people who have the right skills immediately available. In addition, most lifelong learning programmes are about providing very specific technical skills, not about the general cognitive skills that are essential for a labour market dominated by automation and innovation. The following solutions are therefore essential:

1. Companies should take responsibility for training their employees, to help them develop their potential beyond current tasks and to anticipate future changes. This implies a rebalancing of training responsibilities between educational institutions, public employment services and companies. In fact, the role of public employment services should not be limited to helping the unemployed, but should also include helping employed people to prepare for career transitions, in cooperation with the companies where these people are employed. This is mutually beneficial, as it would substantially reduce the financial burden of paying unemployment benefits for the State and for social partners.

   There are interesting good practices: in Google, employees are encouraged to spend up to 20 % of their working time on personal projects and training. This percentage seems huge, it means four days a month or one month-and-a-half every year for adapting your skills, but it is a profitable investment for the company, and it gives more responsibility and autonomy to employees as they can pursue personal projects. This approach significantly reduces the trauma and costs of having to let go of staff with outdated skills, and makes it possible for the company to benefit from innovations and business ideas developed by their employees.

2. The way university degree programmes are organised should be reformed – the length of initial training should be shortened and it should focus more on soft and interdisciplinary skills. Students should then be able to leave in the middle of their studies to go work in a company and gain some on-the-job experience. Having gained practical knowledge, skills and experience, students would then return to their university to finish their studies and upgrade their skills. This will facilitate job adjustment and continuous training. A useful starting point to develop such a new *modus operandi* is Stanford's 'open loop university' concept.

3. A new educational phase should be created: the mid-career education, also linked with the above reorganisation of university education, putting more emphasis on completing and updating degrees during a professional career. Also, when observing the VET institutions that cater to the needs of workers in transition, it can be concluded that they are ill equipped to provide general cognitive skills, and are often not organised enough to cater to the needs of adults who have socioeconomic constraints and basic skills issues. Often, they provide technical training in a specific

sector (training as a carpenter or an electrician), but not the cognitive skills that will give people the resilience they need in a volatile labour market.

A new type of 'school' should also be envisaged under this educational phase - the mid-career school. Its students should not be mostly unemployed people trying to get back into the labour market. Rather, the school should be used as a way to anticipate skills needs, avoid redundancies, and when appropriate, prepare career transitions. This 'school' does not need to be necessarily a physical bricks-and-mortar institution. Rather, it could be imagined as a virtual reorganisation of existing adult learning schemes and programmes.

4. Adult learning, whether provided through companies or the mid-career 'school', should be tailored to the needs of adult students, much more than in any kind of existing schools. For example, there should be a repair component in all the cases where the adult concerned has an issue with basic, literacy, numeracy and digital skills. There should also be a strong component related to general cognitive skills and this needs to outweigh any specific technical learning. Finally, the informal skills acquired by workers in their jobs should be evaluated so that a recognition/certification of these skills can be provided. To achieve this, certification of skills learned on the job should be introduced by consortiums of companies and should receive equivalence to formal credentials provided by the education system.

   In addition, there needs to be flexibility in the way teaching is delivered to avoid income losses for workers, for example flexible teaching hours and processes (online teaching can be an important element). It is also important to make sure that the teaching is adapted to workers who left schools a long time ago, and to workers who sometimes do not have an immediate appetite for learning again. To this end, VET institutions and universities should provide a 'post-sale' to their alumni in the form of reskilling services, coaching, online classes or sessions adapted to the constraints of adults.

There are financial benefits for all stakeholders in reforming adult education: the State, as the financial burden of unemployment benefits will be reduced; employers, as the skills mismatch that is the main problem they identify with labour markets will be reduced; and employees, as they will have more skills, and therefore better prospects for higher-quality and better-paid jobs. The funding of these solutions should therefore be shared, via a contribution from each stakeholder, including the employee who should contribute by paying a reasonable tuition fee.

Member States, companies, workers and the European Commission all have a role to play in addressing this recommendation. Governments would be responsible for operationalising the concept, preparing the curricula and anticipating the necessary skills together with companies, as well as managing the transitions through their public employment services.

Private employment services should also be involved. Making adults want to continue learning is a bigger challenge than fixing the current lifelong learning system. While public and private authorities might have a role to play, workers must realise the importance of lifelong learning and must be willing to take up training and education. The European Commission can support this recommendation by sharing good practices, investing in people's skills through the European Structural and Investment Funds, and supporting skills anticipation.

7.2. On building AI capacity in Europe

Imagine yourself as an eighteen-year-old, who is great with computers, knows a thing or two about coding and algorithms and would like to have a career in developing AI technologies. Where do you do that? Do you go to the United States, which is (still) the undisputed leader in the field? Alternatively, Canada, if you feel drawn to the proverbial Canadian hospitality? What about China? You've heard that they are pretty good at AI too. Oh yeah, there is also Europe. But what would convince you to pick Europe over the other destinations?

7.2.1. Creating AI hubs in the EU

To foster AI development in the EU, a number of European AI hubs should be created. These hubs would be where researchers, academics and investors work closely together. This implies the following:

1. A top-class computer infrastructure and access to large investment facilities, funded from public resources as well as by consortiums of companies pooling their funds. Several super laboratories funded by public resources should be created to offer the necessary computing capacity for SMEs and researchers to develop AI algorithms and process data sets. The European High-Performance Computing Joint Undertaking could be the basis for this.

2. Each of these hubs should act both as a centre of excellence for research and as an education centre that disseminates expertise on AI, running programmes for students and academics specialised in AI. In fact, students and researchers should be offered the flexibility to combine different activities, for example working in a lab while at the same time working in an industry on a specific project.

3. The hubs should be connected to industries, so that the most promising research results can be quickly transformed into industrial innovation, and so that the students who have developed expertise in AI have the opportunity to quickly make their expertise operational. A common pool of money should be made available to finance AI-related masters and PhD programmes. This could be financed for

example from the digital skills strand of the Digital Europe programme and combined with contributions from Member States, universities and industry. To address labour market needs, universities should review their curricula to offer more computer science programmes focusing on AI and robotics.

4. A dedicated AI University along the lines of the MIT AI College should be set up and properly funded.

These AI hubs should be based on excellence rather than the principle of 'juste retour'. To make them credible, the hubs should have global impact and relevance. As such, they cannot be based in all Member States. Nevertheless, to avoid further intensifying geographical cleavages between frontier and laggard regions, the benefits (such as know-how) should be more widely distributed. To scale up and lead to innovation, these hubs will require financial and operational autonomy from Member States and the Commission.

The EIT has been created based on the concept of a virtuous triangle between research, industry and education. Potentially, the EIT could have been the basis for the AI hubs as well. However, the volatility of some of the parameters and the need for quick adaptation requires agility and flexibility, making the EIT an unlikely candidate to operationalise the AI hub concept.

One solution is to endorse existing academic approaches to a European effort on AI. However, there should be a European scale to the effort and a more consolidated approach, as in this case more competition is not necessarily a good thing. Such an approach would need to make sure that there is a clear link between fundamental and applied research. Furthermore, the founders of the ELLIS and CLAIRE initiatives do not seem to want to merge them, though this might change given appropriate public policy stimuli.

Another solution is to create a consortium run by corporations active in AI. Some US companies have started research labs in universities. They include Amazon, Microsoft and Apple in Cambridge, Facebook in Paris, Google in London and Paris and Qualcomm in Amsterdam. However, these operations are fragmented; they need to have a structure that pools resources, to organise attractive programmes for researchers and students, and to ensure their transition to employment that benefits European AI needs. This solution would need to take into account the value-driven and human-centric approach that characterises Europe's attitude towards AI development. Given that none of the eight global companies driving AI development efforts today are European, this approach would not necessarily be conducive to truly independent European capabilities in the sphere of AI.

Member States, academic institutions, industry and the European Commission all have a role to play in addressing this recommendation. Member States can facilitate cooperation between industry and academia, while universities and industry can build on already existing networks. The Commission should provide some logistical and financial support.

7.2.2. Enabling the mobility of AI specialists

In order to attract the best AI talent in the world, it is not enough to provide pools of AI excellence in Europe and to offer motivating salaries to potential candidates. AI specialists are mobile by definition, they will move to places and environments that are mobility-friendly. This is not fully the case in Europe:

1. Legal immigration rules should be adapted to people who will stay in Europe to pursue a specific project for a number of years and then move on; they want to have the possibility to move to and work in all European countries. Hence, the adoption of the Blue Card proposal is an essential element of attracting talent from outside the EU, in particular because of the flexibility it gives individuals.

2. In addition, the Commission should build on the existing mobility schemes (Marie Curie, Erasmus Pro, Your first Eures job, etc.) to create a specific mobility scheme designed to attract the best young AI professionals to work in Europe for a period of 1 to 2 years, and to send the best European AI professionals abroad to be trained in AI. Obviously, such a scheme would require some features that are different from those of classic Erasmus programmes. The financial resources would need to be substantial, not only stipends to support individuals during their stay in Europe, and the scheme would need to be organised through a bilateral agreement between two companies or organisations. The recently launched digital opportunities traineeship financed by Horizon 2020 and implemented through Erasmus+ is a useful first step, and could be built upon. It gives students of all disciplines the opportunity to get hands-on digital experience in fields in which market demand is high.

Member States and the Commission have a role to play in addressing this recommendation. Governments should agree on a system to facilitate the immigration of AI specialists from outside the EU. The Commission can help to make this system operational.

7.3. On work organisation

> Imagine if Otto von Bismarck could witness the current labour market transformations. Would he consider the social protection system he put together a century and a half ago to still be appropriate to address current realities?

7.3.1. A universal safety net

As we are moving to a new economy where the delineation between labour and the provision of services is becoming blurred, it is important to ensure that the costs of social safety nets are shared by individuals, companies and the State. Today, social contributions based on work-related income still represent the largest part of social protection receipts.

However, the financing of social protection is gradually shifting to general taxes: it represented 45 % of total resources in 2014, whereas it was 40 % in 2000 and 35 % in 1995. This trend will accelerate with the rise of self-employment, as the social protection that is not provided through contributions paid by employers and employees will eventually be covered by the State. This is why it is essential to adapt the funding and organisation of social protection to the new situation:

1. Every individual should have a universal personal account providing insurance against the main risks covered by employment/social protection and career transitions. This means maternity leave, illness, invalidity, pension and unemployment, but also adult vocational education and training.

   This personal account should have a saving function, allowing individuals to build their own savings and withdraw part of their funds at some point to start their own business or do specific training to prepare for a career transition.

2. The risks should be covered through a traditional insurance model funded by contributions paid by individuals and by the companies that employ them or use their services.

   More specifically, the funding could be ensured through a generalised social contribution, a small amount levied on all services provided through and billed by platforms (Uber, Airbnb, TaskRabbit, etc.). This will resemble how VAT works. A simplified example is taking a ride with a car-sharing service, which costs a total of EUR 10. Out of this, EUR 1 goes to the social protection of the driver. This will all be paid by the customer so that online platforms are not disadvantaged. Online platforms will remain responsible for collecting the contributions. At the same time, social contributions from 'traditional' employers and employees with labour contracts will continue to be collected.

3. The universality of such an account implies the possibility for the individual to accumulate credits (for instance for training) for a number of years, and decide to use them at a certain point in time for a major requalification necessitating a long training period, for instance a one-year programme at a university. However, it also implies the possibility to withdraw from credits accumulated, for instance for pensions, and use them for training or to constitute the capital necessary to start a company. Obviously, there should be limits on how much can be transferred from one component to another, so that the major social risks remain adequately ensured.

Whether such an account should fully replace current social protection systems or be implemented alongside them for platform economy workers would ultimately depend on how fast and how much the gig economy grows.

Member States should create and operationalise the individual accounts system. In cases that concern cross-border situations, the European Commission has a coordination role to play between the different national systems.

7.3.2. Collective representation

There is a clear need for collective representation for all new situations, platform workers, freelancers and the self-employed in general (both part- and full-time):

1. It is essential to create a forum for discussing fees and working conditions (working time, health and safety, training etc.), allowing the possibility to reach the equivalent of collective agreements.

2. This should be done by sector to reflect the specificities of each occupation (working condition issues will not be the same for an Uber driver and an Airbnb accommodation provider). This would mean creating the equivalent of guilds: for instance, for transportation, one could imagine that one side would be made up of Uber and its competitors like Taxify, Le cab, Chauffeur privé, Lyft etc. The other side would include all the drivers working for these sites (also because a substantial number of them work for several sites at the same time).

   A similar concept already exists in France for artists (the *intermittents du spectacle* system). It puts together employer' and worker' contributions to fund the artists' unemployment insurance system.

Social partners are the main actors that need to address this recommendation. Member States will need to adapt the legislative framework under which social partners operate. The European Commission can support all parties by sharing good practices.

7.4. On support for entrepreneurship and uptake of AI by SMEs

> Imagine having a computer, which, for one reason or another, has some of its components running on the newest operational system, while most of it is still on pre-Windows-age software. How would that affect your usage of the computer? Given the choice, would you favour using the programmes that are more agile, faster and better able to respond to your needs? How would this dissonance of elements affect the overall performance of the system?

This analogy shows what an economy would look like if only some companies adapt to the AI age. To address this possibility:

1. Dedicated funding should be made available to SMEs for the transition to the AI economy. This funding could be used for example to support the creation of AI

management consultancies for SMEs, to further fund European open libraries for algorithms, to customise openly available algorithms or to attract AI talent.

2. Open data pools fed by companies and public institutions should be created (taking into account privacy considerations) to overcome data monopolies. The vast amounts of data available to public institutions should be put to use to support the AI transformation of the economy. Some Member States (such as France) have already started doing this, which is a welcome development. Open data sets should also be more diverse, and this should be an obligation for public and private entities alike. Private companies' initiatives, such as the Google Dataset Search, should be encouraged, as they make it easier for SMEs to locate and use open datasets. This should be done in line with certain safeguards to provide for neutrality in the provision of aggregated data and monitor competition and data monopoly issues.

Member States, the European Commission and companies all have a role to play in addressing this recommendation. Member States can review the existing incentives for businesses to implement and use AI and ensure that they are adequate, sufficiently promoted to all companies, and designed to assist SMEs wherever possible. Dedicated funding could be made available to SMEs to implement AI in their business models. Publicly available datasets could be made available for re-use by others in AI applications that serve the public interest. This should be done in line with diversity and privacy considerations. The Commission can leverage national spending with the European Structural and Investment Funds, coordinate national efforts where appropriate and share good practices in helping SMEs transition to the AI economy. Companies can support the establishment of open data pools and European algorithm libraries.

7.5. On improving societal support for the digital transformation

> Imagine being a regular citizen, who does not understand much about how artificial intelligence affects their life in particular and society in general. You have heard about the possible risks (i.e. of losing your job to a robot) but are unaware of the opportunities to improve your life brought about by the new technologies. Why should you want or support an AI revolution in the economy?

Citizens must be reassured of the fact that artificial intelligence will be used to their benefit, in full respect of the social values that are the foundation of the European Union. To this effect:

1. Mechanisms that help avoid blind spots, remove bias and handle sensitive issues such as beliefs and religions should be introduced by companies when artificial intelligence is used. These mechanisms, such as safeguards embedded in the

algorithms, should guarantee the freedom of expression and of association and prevent invasions of privacy, social exclusion and discrimination. They should be transparent and it should be possible for the relevant national or European authorities to monitor them and carry out checks.

2. More generally, a governance system should be set up to monitor the progress of artificial intelligence systems at European level, and to propose measures of redress when necessary. The recently launched European AI Alliance is a useful first step, in particular to monitor and anticipate development, especially as it is difficult to predict the future technical advances and their implications.

3. It would be useful to also set up a Systemic Risk Board, modelled on the EU level board created after the financial crisis to monitor risks in the financial sector. This board, composed of experts and stakeholders, would have the task of detecting and anticipating possible misuses of artificial intelligence or distortions of data, and of proposing measures of redress in an annual report to the European Commission.

4. Public authorities have a key role to play in monitoring the social impacts of artificial intelligence and digital technologies at national level. This requires them to look at all aspects, including privacy, gender, discrimination and inclusion issues, from an ethical as well as a legal perspective. The natural option is to put in place an observatory that gathers technology experts, decision-makers and stakeholders and to give them the mandate to make recommendations as appropriate.

5. These national observatories should work in complementarity with the proposed EU AI Systemic Risk Board and could be organised in a network along the lines of the Consumer Protection Cooperation Network. They should also encompass task forces looking into establishing processes for determining whether automated systems are fair, equitable and accountable. It could be done similarly to what the New York City Council task force has done. Ultimately, the goal of the task forces will be to identify ways in which algorithmic decision-making can be made more transparent.

Most of the issues concerned also have international implications, which makes it difficult to limit governance to a national level, the risk being that different standards may damage the sustainable development of AI. International discussions should thus be launched to reach a common understanding, or to create a coalition of countries as all products and services resulting from AI are global by nature. There are ongoing reflections in Canada on a proposal to create an international organisation for artificial intelligence. The United Arab Emirates have also expressed interest in such an idea, having already appointed the first AI Minister in world history. It seems a valuable concept, especially as it would first focus on creating a coalition of willing countries, prepared to discuss and agree on a voluntary set of rules and standards. Some initial steps to promote international cooperation in AI have already been taken. For example, France and Canada have agreed to create an international

working group focused on AI ethics. Within the European Union, the recent Franco-German treaty signed in Aachen in January 2019 has also emphasized the importance of promoting international ethical guidelines for new technologies, including AI.

Member States, the European Commission, companies and social partners all have a role to play in addressing this recommendation. The effort must be undertaken collaboratively and must involve all stakeholders.

7.6. On an AI mission statement/charter

> Imagine being an AI developer, who is fascinated with the possibilities for scientific progress promised by the technology. There are so many opportunities to push the boundaries of knowledge and overcome the limitations of human beings. You could create something new, something smarter, stronger, quicker and essentially better than a human being. Imagine all the possibilities this could open. Why on Earth should you not try to do that? What could possibly go wrong?

Citizens need to see a commitment from policymakers and developers alike that AI will be developed and applied thoughtfully and responsibly. Otherwise, there will be a lack of public cohesion, as was the case for other important technological developments, which have been the subject of fierce public debate (such as GMOs for example). This requires a mission statement, a set of general principles or a declaration that should be endorsed by European governments, as well as the main stakeholders, such as the social partners. Based on a set of principles proposed by Google, as well as the Asilomar AI Principles, they should cover the following points, forming a solemn commitment to the fair use of AI:

1. AI should benefit as many people as possible and these benefits should clearly outweigh any risk or downside. The economic prosperity created by AI should be shared broadly, to benefit all of humanity.

2. AI should be neutral, avoiding any bias, in particular regarding race, ethnicity, gender, income, sexual orientation, political or religious belief.

3. AI should be accountable to people who can provide full explanations of results or decisions, and should be subject to human control.

4. AI should safeguard privacy, and its use of data should be transparent and possible to control. People should have the right to access, manage and control AI-generated data.

5. AI should be tested for excellence in safety, designed to be cautious and provide transparency on risks and failures.

6. Investment in AI should be accompanied by funding for research on ensuring its beneficial use.

7. There should be regular constructive and healthy exchange between AI researchers and policymakers.

Providing reassurance, support and encouragement to the public about AI is essential, as is a clear and transparent governance framework. This is a prerequisite to championing the sustainable use of AI. Work is already ongoing on European level to address the need for a set of ethical guidelines on the use of AI, with the high level expert group on AI due to release its ethical framework for AI in spring 2019.

Member States, the European Commission, industry and the social partners all have a role to play in addressing this recommendation.

7.7. On appropriate funding for managing transitions

> Imagine having to pay for all the labour market transitions brought about by artificial intelligence and robotisation. Where would the money come from?

Looking at the link between public and private responsibility for providing the right skills, it seems that accumulating human capital requires investment at all levels. Governments can create an enabling environment but public investment alone is insufficient. Companies have to invest in their employees and employees need to invest in their continuous education.

Given the possibility for large-scale labour market disruptions, appropriate funding should be ensured for retraining:

1. Building upon the idea to put in place investment incentives for human capital development, a financial instrument should be created to support reskilling by tapping financial markets and lending directly to workers. In designing such an instrument, two prerogatives should be kept in mind - providing incentives for companies to use the fund to train their workforce and getting on board financial institutions. Making such an instrument attractive to financial institutions could be achieved by loan guarantees provided by Member States. The financial repercussions for the Member States budgets will be partially offset by decreased spending on unemployment benefits due to better match between skills demand and supply and lower unemployment. Such a financial instrument needs to be available on a continuous basis, viable without large interventions by Member States and independent of political cycles.

2. This newly created instrument should fund training programmes, which target occupations facing labour shortages and specific skills in high demand by companies. Such jobs and skills could be decided on a country-by-country basis. Training curricula could be defined and regularly updated based on the best educational practices.

   Such a financial instrument promoting investment in human capital development could also be supported through the InvestEU Programme. In the area of skills and human capital development, the Commission has identified and is currently exploring a number of potential opportunities for developing financial instruments (mainly through loan schemes) in the context of the InvestEU Social Window. These target mainly investment into the development of company-specific human capital (training, reskilling or upskilling through vocational education and training programmes, for students, apprentices, young and adult learners) supported by different financial incentive schemes targeted at SMEs.

   However, a dedicated financial instrument to investment in human capital development would need to go beyond the current scope of the InvestEU Social Window. What is currently foreseen under this policy window are company loans and social impact schemes. Individual micro loans are only considered for people wishing to start their own business - microenterprises. To be fully adapted to address the labour market transitions stemming from artificial intelligence and robotisation, a dedicated financial instrument would also need to include guarantee schemes for personal training loans.

3. The setting up of such a fund should be combined with the reform of unemployment insurance. Unemployment insurance schemes should be reinvented to include a preventive component, essentially 'employability insurance'. The concept would be similar to how health insurance works. Physical well-being requires both preventive and curative care. In much the same way, the impending job market disruptions and displacements require similar types of support so that workers can maintain meaningful and financially stable employment.

In its proposal for the next multiannual financial framework, the Commission put forward an idea to create a new Digital Europe programme with an overall budget of EUR 9.2 billion to shape and support the digital transformation of Europe's society and economy. Among the five priorities in the proposal, EUR 2.5 billion over seven years is planned to help spread AI across the European economy and society. An additional EUR 700 million should ensure that the current and future workforce will have the opportunity to easily acquire advanced digital skills through long- and short-term training courses and on-the-job traineeships, regardless of their Member State of residence.

This is a welcome first step but the amounts involved seem insufficient, bearing in mind the magnitude of transitions to be faced and the investments made in the field by other major international players. Europe as a whole (EU and national levels, but also the private sector) needs to spend much more to tackle the challenges stemming from AI and make full use of the opportunities the technologies offer. In addition, when it comes to investment in AI, the 'juste retour' principle in European budgeting should be considered counterproductive. Europe needs to spend not only more but also more strategically on AI. As far as AI development is concerned, putting all eggs in a very limited number of baskets is the way to go.

There are already EU-level structures in place that could be further leveraged to tackle the workforce transitions stemming from the increased uptake of AI. The European Globalisation Adjustment Fund (EGF) already provides support to people losing their jobs because of major structural changes in world trade patterns due to globalisation, e.g. when a large company shuts down or production is moved outside the EU, or because of the global economic and financial crisis. The EGF should be upgraded to an EGF+ and its scope should be extended to include transitions resulting from AI and automation. Appropriate funding for this EGF+ should also be made available, and could come from the EU, national and private/corporate levels.

Member States, the Commission, social partners and companies all have a role to play. Member States can ensure appropriate funding for managing transitions, both at national and European level. The Commission can leverage national spending with the European Structural and Investment Funds. Social partners can help devise and reform training curricula. All stakeholders can foster the uptake of AI by small and medium-sized enterprises, which is key to a successful digital transformation.

CHAPTER 8

CONCLUSIONS

As this report has shown, a major shift in the economy is taking place. All the major components of automation are increasingly taking over various tasks traditionally carried out by people or performing tasks that were beyond reach until now. This transformation seems to be taking place silently, effortlessly, but in fact creates insecurity and anxiety for many workers, citizens, consumers and patients as to the place of humans in society.

This insecurity by-and-large stems from the fact that nobody knows what tomorrow's jobs will be, whether our free will as citizens, consumers and patients will be maintained, or whether life choices will be increasingly dictated by automated systems.

Two facts are clearly established:

- Trying to resist, slow down or stop the advances of artificial intelligence or robotics will simply increase the cost of adaptation, make companies, workers and societies less competitive, less employable and less relevant.

- Time and again, we have faced major technological disruptions with the same insecurity and anxiety, and history shows that each time our societies did not manage these transitions well, which resulted in major difficulties, unrest or crises.

We should be all the more focused on managing the transition better this time now that there is a clear acceleration of technological changes. To manage these transitions, instead of reflecting on how new technologies can help our existing jobs or business models, we need to focus on how to reorganise them to take the most advantage of the new technologies. We also need to rethink the organisation and move towards more horizontal structures, review business models to improve services provided to customers, accordingly upgrade jobs for workers. All these changes can be made possible using automation and can provide new opportunities for businesses and workers.

The fact than similar transformations took place in the recent past without major problems should not support a 'wait and see'/'business as usual' approach. These transformations provide important opportunities for positive changes towards quality jobs and more competitiveness: for Europe, this means a renewed capacity to compete on the global market with our highly-skilled workers and our innovation systems, especially in areas where we have lost jobs to cheap labour. However, this requires:

- A major investment effort in research, education, IT infrastructure and systems to be shared between public budgets and companies; some countries have already showed that they are prioritising this.

- A major rethink of education; creating education aimed at adults, not simply a few retraining sessions scattered over the course of a career, giving young people the capacity to learn rather than feeding them with technical knowledge that can quickly become obsolete.

For decades, Europe has been lagging in terms of productivity and competitiveness; we have sometimes portrayed ourselves as victims of globalisation, losing jobs to other countries whose citizens have lower work standards. Artificial intelligence is our opportunity to be on top of the game again.

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ANNEX I

AI STRATEGIES IN SELECTED MEMBER STATES AND NON-EU COUNTRIES

France 

French President Emmanuel Macron presented the country's AI strategy on 29 March 2018 at the AI for Humanity event. The French government plans to invest EUR 1.5 billion over five years to support research and innovation in the field.

The national strategy is largely based on recommendations from the 'For a meaningful Artificial Intelligence: towards a French and European strategy' report (March 2018). The report is the result of a six-month project carried out by Cédric Villani — French mathematician, Fields Medal winner and Member of Parliament — and his team.

The key proposals of the Villani Report on AI are as follows:

Developing an aggressive data policy – by encouraging companies to pool and share their data, creating data that is in the public interest and supporting the right to data portability.

Targeting four strategic sectors (health, transport, the environment and defence and security) – by implementing sector-specific policies focusing on major issues, testing sector-specific platforms and implementing innovation sandboxes.

Boosting the potential of French research – by creating interdisciplinary AI institutes in selected public higher education and research establishments, allocating appropriate resources to research, including a supercomputer designed especially for AI applications in partnership with manufacturers and making careers in public research more attractive by boosting France's appeal to expatriate or foreign talent.

Planning for the impact of AI on labour – by setting up a public laboratory on the transformation of work, developing complementarity between humans and machines and testing new funding methods for vocational training.

Making AI more environmentally friendly

Opening up the 'black boxes' of AI – by developing algorithm transparency and carrying out audits, considering the responsibility of AI actors for the ethical issues at stake, creating a consultative ethics committee for digital technologies and AI, which would organise public debate in this field, and guaranteeing the principle of human responsibility, particularly when AI tools are used in public services.

Ensuring that AI supports inclusivity and diversity – by ensuring that by 2020 40 % of those enrolled in digital engineering courses are women, modifying administrative procedures and improving mediation skills and supporting AI-based social innovations

Source: https://www.aiforhumanity.fr/

Germany 

In November 2018, the German government released more details on its planned national AI strategy, at the heart of which is an expected second-wave of AI development focused on industrial rather than consumer data.

At the heart of the released details is a plan to make huge amounts of data available to German researchers and developers, improve conditions for entrepreneurs, stop a brain drain of AI experts and loosen regulation in certain areas. The plan focuses on three key sectors – the car industry, manufacturing and the healthcare sector.

Germany is planning to spend EUR 3 billion until 2025 on the implementation of the strategy.

In the meantime, other related initiatives are underway. For example, the German Institute for Innovation and Technology within the Federal Ministry for Economic Affairs and Energy is currently undertaking a study on the Potential of AI for Industry (PAICE) in Germany.

The Federal Ministry of Education and Research (BMBF) launched a government aid campaign in the field of machine learning in 2017. This is intended to improve training and professional education in machine learning, to support basic research and to create internationally visible machine learning competence centres throughout the country. For example, BMBF funded the Platform Learning Systems, which is an expert platform for AI running from 2017 to 2022. Since 2015, BMBF has also funded the Automated and Networked Driving project.

In June 2017, the German Federal Ministry of Transport and Digital Infrastructure (BMVI) published ethical guidelines for self-driving cars in a report entitled, 'Ethics Commission: Automated and Connected Driving,' which defines 20 ethical rules for automated and connected vehicular traffic.

Sources: Politico Pro https://www.politico.eu/article/germanys-plan-to-become-an-ai-powerhouse/ ; https://futureoflife.org/ai-policy-germany/

The United Kingdom 

On 6 March 2018 the UK government launched a Sector Deal for AI led by Business Secretary Greg Clark. The deal aims to take 'immediate, tangible actions' to advance the UK's AI ambitions that are consistent with its industrial strategy (see below).

Parliament established the Select Committee on AI in June 2017 to consider the economic, ethical and social implications of advances in artificial intelligence, and to make recommendations. In April 2018, the Committee published a 183-page report, 'AI in the UK: ready, willing and able?' which considers AI development and governance in the UK. It acknowledges that the UK cannot compete with the US or China in terms of funding or people, but suggests the country may have a competitive advantage in considering the ethics of AI.

The Committee report encourages the UK to establish a national AI strategy and proposes an 'AI Code' with five principles: (i) artificial intelligence should be developed for the common good and benefit of humanity; (ii) artificial intelligence should operate based on the principles of intelligibility and fairness; (iii) artificial intelligence should not be used to diminish the data rights or privacy of individuals, families or communities; (iv) All citizens have the right to be educated so that they are able to flourish mentally, emotionally and economically alongside artificial intelligence; and (v) The autonomous power to hurt, destroy or deceive human beings should never be vested in artificial intelligence. In June 2018, the government responded to the report's recommendations in a 41-page document. Its response highlights many of the UK's intentions and recommendations for managing the development of AI moving forward.

The UK government's industrial strategy was published in November 2017. One of the four main challenges is to put the UK at the forefront of the AI and data revolution. The document states, 'Embedding AI across the UK will create thousands of good quality jobs and drive economic growth. A recent study found digital technologies including AI created a net 80 000 new jobs annually across a population similar to the UK. By one estimate, AI could add GBP 232 billion to the UK economy by 2030.' The industrial strategy also described a plan to take an 'international leadership role' by investing GBP 9 million in a new Centre for Data Ethics and Innovation. This advisory body aims to review the existing governance landscape and advise the government on ethical, safe and innovative uses of data, including AI. Finally, the strategy announced a new 'future sectors' team that will help grow the sectors developing 'the technologies and business models of the future, such as robotics and artificial intelligence.'

Source: https://futureoflife.org/ai-policy-united-kingdom/

Sweden 

In December 2017, the Swedish government commissioned Sweden's innovation agency Vinnova to conduct a landscape of AI in the country. The resulting report, entitled 'Artificial intelligence in Swedish business and society: Analysis of development and potential,' highlights AI capabilities and prioritises several initiatives and opportunities for the country.

In May 2018 Sweden released their 'National approach for artificial intelligence,' a 12-page guiding document outlining the governments' assessment of what is needed for the country to be at the forefront of AI development and use. The document highlights the government's goals to develop standards and principles for ethical, sustainable and safe AI, while acknowledging existing national and international regulations and norms. These goals are: to continue to improve digital infrastructure to leverage opportunities in AI; to increase access to data; and to play an active role in the EU's digitisation efforts.

The Swedish government has since made several efforts to implement the strategy. For example, it invested SEK 40 million in several universities for 2018 and 2019 to help train AI professionals. Sweden's innovation agency Vinnova has also announced that it will be investing significantly in AI over the next 10 years. Additionally, the Swedish Digitalisation Minister Peter Eriksson launched an AI Arena in Gothenburg at the Lindholmen Science Park to enable collaboration and strengthen Swedish companies.

Source: https://futureoflife.org/ai-policy-sweden/

Finland 

Finland has an artificial intelligence programme led by a steering group that was appointed by Minister of Economic Affairs Mika Lintilä in May 2017. The steering group falls under the Ministry of Economic Affairs and Employment, and is led by Pekka Ala-Pietilä, CEO and co-founder of Blyk and former President of Nokia.

The group published their first report in December 2017, entitled 'Finland's age of artificial intelligence: Turning Finland into a leading country in the application of artificial intelligence.' This 76-page report gives eight proposals through which Finland can successfully adopt and benefit from AI:

1. Improve business competitiveness through the use of AI
2. Use data more effectively across all sectors
3. Ensure AI can be adopted more quickly and easily
4. Ensure top-level expertise and attract top experts
5. Make bold decisions and investments
6. Build the world's best public services
7. Establish new models for collaboration
8. Make Finland a front runner in the age of AI

The report also sets out a vision for Finland in the age of AI, described below.

In another five years' time, artificial intelligence will be an active part of every Finn's daily life. Finland will make use of artificial intelligence boldly in all areas of society – from health care to the manufacturing industry – ethically and openly. Finland will be a safe and democratic society that produces the world's best services in the age of artificial intelligence. It will be a good place for citizens to live and a rewarding place for companies to develop and grow. Artificial intelligence will reform work as well as create well-being through growth and productivity.

The Steering Group published a second report in June 2018, entitled 'Artificial intelligence: Four perspectives on the economy, employment, knowledge and ethics.' The report provides 28 policy recommendations related to the effects of AI on economics and employment, the labour market, education and skills management, and ethics.

Source: https://futureoflife.org/ai-policy-finland/

Estonia 

Estonia has long been at the forefront of e-governance by instituting digital technologies into government and throughout its society. The country is now investing in AI, and developing a legal framework around its use. Initially, the Estonian government was pursuing the best way to introduce autonomous vehicles onto its roads, but then determined that it was better to develop broader plans for AI, ones that are not sector-specific given that questions around issues such as cybersecurity, enforcement and ethics cut across sectors. By developing a holistic approach, Estonia hopes to encourage quicker dissemination of these technological developments.

Estonia is developing a bill on AI liability, which will be ready in March 2019. The government hopes that this legal framework will attract investors by providing a simple, comprehensive guideline that enables the broad use of AI systems. This effort will be supported by the use of a closed blockchain system, which is intended to promote data integrity and security. To inform the bill and the discussion of the issues at stake, Estonia launched a public debate and consultation in September 2017. The government will also establish an AI Task Force to draw up legal, business and communications strategies.

Source: https://futureoflife.org/ai-policy-estonia/

Austria 

Austria set up a Robot Council in August 2017, launched by Infrastructure Minister Jörg Leichtfried and given one million euros as a working budget. The Robot Council is an advisory body that will assist the Ministry of Infrastructure with developing an AI strategy over a two-year period. It is chaired by Professor Sabine Köszegi and has an eight-member team of international and Austrian experts in computer science, robot ethics and other fields. The Council is working to identify technical, economic and social opportunities and challenges in the areas of robotics, autonomous systems and AI. Council members plan to identify research and business needs, legal requirements, and social and ethical values. In January 2018, the new government proposed the establishment of an Ethics Council for Digitalisation, which would collaborate or merge with the Robot Council.

Prior to setting up the Robot Council, the Ministry commissioned a representative survey of 1 000 Austrian citizens and found that around two thirds of the population want Austria to develop a strategy for handling robots and AI in the country. The survey also identified views about appropriate and inappropriate uses of robots throughout society. Minister Leichtfried has emphasised finding the right way to integrate robotics and AI into the lives of Austrians.

Austria also has the Austrian Society for Measurement, Automation, and Robotics Technology, which set up the National Robotics-Technology Platform (GMAR) in 2015, supported by the Austrian Ministry of Transport, Innovation and Technology. GMAR aims to (i) promote networking and information exchanges among key players; (ii) secure Austria's competitiveness in these industries; (iii) promote robotics, automation, and AI technology; (iv) provide advice to policy makers; and (v) connect internationally relevant communities.

Source: https://futureoflife.org/ai-policy-austria/

The United States 

In February 2019, President Trump signed an executive order entitled 'Accelerating America's Leadership in AI' that creates the American AI Initiative. It includes five pillars: (i) investing in AI research and development; (ii) unleashing AI resources; (iii) setting AI governance standards; (iv) building the AI workforce; and (v) international engagement and protecting the US AI advantage. The American AI Initiative aims to focus the resources of the Federal government to develop AI in order to increase US prosperity, enhance its national and economic security, and improve quality of life for the American people. No funding information has been released yet.

In May 2018, US President Trump and the White House held a summit on artificial intelligence for American industry that included key technology companies. The White House also released a fact-sheet entitled 'Artificial intelligence for the American people,' which highlights the Trump administration's priorities for AI: funding AI research, removing regulatory barriers to the deployment of AI-powered technologies, training the future American workforce, achieving strategic military advantage, leveraging AI for government services, and working with allies to promote AI R&D. The White House announced plans to help provide US companies with new data sources, and to establish a Select Committee on artificial intelligence that will help government agencies think about and use the technology, as well as consider partnerships with industry and academia.

As of July 2018, the Department of Defence (DoD) has additionally established a Joint AI Centre (JAIC) to explore the agency's use of AI, though the details are still being determined. The JAIC will supposedly work on AI 'national mission initiatives;' improve collaboration with the private sector, academia and military allies; attract AI talent and establish an ethical framework for AI; and aid in implementing the National Defence Strategy. The DoD may also soon publish an AI strategy.

President Trump was the first US president to specifically name artificial intelligence as an administration R&D priority in his 2019 budget request to Congress. Under his administration, AI was also featured for the first time in the National Security Strategy, in its role in helping the US lead in technological innovation as well as its role in information statecraft, weaponisation and surveillance. It also shows up for the first time in the National Defense Strategy where it is described as one of the technologies that will change the character of war and give increasingly sophisticated capabilities to US adversaries, including non-state actors. Moreover, autonomous systems that include AI and machine learning are described as one of the primary areas in which modernisation of key capabilities is desired.

Sources: https://futureoflife.org/ai-policy-united-states/;
https://www.whitehouse.gov/articles/accelerating-americas-leadership-in-artificial-intelligence/

China 

In March 2018, Minister of Science and Technology Wan Gang told a press conference held on the side-lines of the National People's Congress that China will soon publish a guideline and detailed regulations for AI. He explained that these would address problems in security, health, environmental protection, social ethics, job structure, personal privacy and national security.

In July 2017, The State Council of China released the 'New generation artificial intelligence development plan.' This policy outlines China's strategy to build a domestic AI industry worth nearly USD150 billion in the next few years and to become the leading AI power by 2030. This officially marked the development of the AI sector as a national priority and was included in President Xi Jinping's grand vision for China.

According to a July 2017 article in The New York Times, a timeline in the new policy explains how 'the government expects its companies and research facilities to be at the same level as leading countries like the United States by 2020'. Five years later, it calls for breakthroughs in select disciplines within AI that will become 'a key impetus for economic transformation.' In the final stage, by 2030, China will 'become the world's premier Artificial Intelligence innovation centre,' which in turn will 'foster a new national leadership and establish the key fundamentals for an economic great power.'

The Ministry of Science and Technology (MOST) and a new office called the AI Plan Promotion Office are responsible for implementing and coordinating of the emergent AI-related projects, which are driven primarily by government-led subsidies. An AI Strategy Advisory Committee was also set up in November 2017 to conduct research on strategic issues related to AI and to make recommendations. This is headed by Pan Yunhe, an academic in advanced manufacturing at the Chinese Academy of Engineering (CAE), who is also deputy chairperson of the China Association for Artificial Intelligence (CAAI). Additionally, an AI Industry Development Alliance was established, co-sponsored by more than 200 companies and agencies nationwide and focusing on building a public service platform for the development of China's AI industry with which to integrate resources and accelerate growth.

MOST has also identified five AI national innovation platforms, which aim to boost AI development. The platform focusing on autonomous driving is led by Baidu; efforts to boost smart city development are spearheaded by Alibaba; Tencent is focusing on AI development for healthcare, while iFlytek specialises in voice recognition. The fifth platform was launched in September 2018 and focuses on computer vision. Efforts in this area are spearheaded by SenseTime.

Source: https://futureoflife.org/ai-policy-china/

Canada 

The Canadian Institute for Advanced Research (CIFAR) is leading the Government of Canada's $125 million pan-Canadian artificial intelligence strategy, working in partnership with three newly established AI institutes – the Alberta Machine Intelligence Institute in Edmonton, MILA in Montreal and the Vector Institute in Toronto.

Announced in the 2017 federal budget, the strategy has four major goals:

- To increase the number of outstanding artificial intelligence researchers and skilled graduates in Canada.
- To establish interconnected nodes of scientific excellence in Canada's three major centres for artificial intelligence in Edmonton, Montreal and Toronto.
- To develop global thought leadership on the economic, ethical, policy and legal implications of advances in artificial intelligence.
- To support a national research community on artificial intelligence.

Over the next five years, CIFAR will collaborate with the Canadian research community to:

- Enhance Canada's international profile in AI research and training.
- Increase productivity in AI academic research and the capacity to generate world-class research and innovation.
- Increase collaboration across geographic areas of excellence in AI research and strengthen relationships with receptors of innovation.
- Attract and retain outstanding AI talent in Canadian universities and industry.
- Translate AI research discoveries in the private and public sectors in socioeconomic benefits for Canada.

Programmes:

- AI institutes. The strategy funds three centres of excellence in AI research and innovation in Canada's three major centres for deep learning and reinforcement learning research – in Edmonton, Montreal and Toronto. These three AI institutes provide a critical mass of research and innovation excellence, and work with researchers, industry and other stakeholders across Canada.
- Canada CIFAR AI (CCAI) Chairs Program. As international competition for machine learning researchers intensifies, the Canada CIFAR AI Chairs Program will help Canada retain and recruit top academic researchers and allow them the freedom to

carry out research, train students and interact with industry. The CCAI Chairs Program supports the recruitment and training of young researchers, including both graduate students and postdoctoral fellows. It includes funding for graduate students who will work with the CCAI Chairs, as well as training for students at the three AI institutes.

- AI & Society Program. Advances in AI will have profound implications for the economy, government and society. The strategy funds policy-relevant working groups to examine these implications, publish their findings and inform the public and policymakers.

- National AI Program. The strategy includes a programme of national activities that build on CIFAR's success with summer and winter schools in AI, and support activities that are national and collaborative in scope such as an annual meeting of Canada CIFAR AI Chairs. The National Program activities will ensure that Canada is well-positioned for sustained global leadership in AI research and innovation.

Source: https://www.cifar.ca/ai/pan-canadian-artificial-intelligence-strategy

ANNEX II

EXCHANGE OF VIEWS WITH THE SOCIAL PARTNERS

During a meeting on 10 July 2018, the following social partners organisations shared their views on the impact of artificial intelligence and automation on the future of work – IndustriAll, BusinessEurope, CEEMET, CEEP, UEAPME and EFAA. Their reflections are summarised below.

IndustriAll (Global Trade Union)

There are significant differences between the AI revolution and previous industrial revolutions, which needed a lot of physical investment to start. With the digital transformation, deployment of technology is much faster, as it is basically software relying on existing infrastructure - computers and the internet. Stagnation of productivity could partly be a statistical effect. The measurement of productivity is value added divided by hours worked and the initial effect of digital transformation has been the lowering of prices and reduction of margins because of increased competition. Even if units produced per hour of work increased, when this is translated into national accounts productivity growth seems low. Another element that makes the current transformation different is the logic of network effects and fixed cost effects. If left unregulated, this leads towards massive concentration of wealth and power. It can be seen in terms of sharing of value added between traditional industries and newcomers.

As regards social protection, the general position is that access should be extended as far as possible. Whether this should be done by pushing platform workers towards regular employment or whether social protection systems should be adjusted is still a matter of internal discussion.

In its current form, machine learning is unexplainable, like a black box. There is no way to track back from teaching data provided to recommendations/decisions made. As soon as decisions about humans are involved, this is problematic - how do you obtain redress, for example? If as an employee you follow the recommendation of a machine, no questions will be asked. If you do not and you make a mistake, you will get sanctioned. The net effect is hence that people will follow machine recommendations blindly.

Machine learning systems are based on the assumption that the future will be like the past - teaching data leading to new decisions cannot come about, so this is a form of conservatism. There is no place for innovation and creativity. If you re-use the output of machine learning as training data, you amplify any potential bias that might be in there.

On the need to reform legislation regarding sharing of value added, digital monopolies and access to data - there could be an argument for non-exclusive mandatory access to

machine collected data. Otherwise, it would be appropriated by large-scale digital monopolies. Any decision taken by an algorithm for humans in terms of employment or career development should be possible to explain.

Predicting the health status of employees can be used for both good and bad purposes – to keep the person in good health preventively, but also to fire a person preventively if they are in danger of developing a long-term disease. This needs to be regulated.

BusinessEurope

The main result of the ongoing digital transformation should be productivity and employment growth. One aspect of why productivity growth could be low is the issue of economic sector redistribution. For example, many of the new jobs being created in the caring services can be considered to be jobs with low productivity growth. The economic transformation needs to encourage companies and workers to shift towards higher value-added sectors.

Complementarity between human and machine labour is very important and the outcome of the AI revolution is not necessarily a situation where people will be replaced by machines. Being part of a job and a company is an important element of social inclusion. While technology will enhance work, some jobs will also disappear. The AI transformation is also expected to have significant repercussions on occupational health and safety.

To reach the objectives of productivity and employment growth, the challenge is to understand the changing business models and evolving forms of work. Regulation needs to support these changes. We also need to adapt existing education and social protection systems at national level. Europe can identify how better outcomes can be achieved and try to support the most successful examples, but the changes must be made at national level.

ETUC, BusinessEurope and CEEP finalised a research project on adults in employment. It shows an increase in the number of employed people undergoing training and the number of companies providing training. No gender imbalance is observed. Older workers do not participate in much training. We need to make sure that the relevance of training provided increases in light of new needs stemming from digitalisation.

More investment is needed in the new MFF, particularly as regards Horizon Europe. Erasmus+ has an increase of 91% in the new MFF proposal compared to the current programme. This is welcome but the focus should not only be on increasing the budget, we must do something different – for example modernising education and training systems.

The notion of unexplainability of machine learning decisions raises the question: to what extent can machines be autonomous? This touches on the ethical dimension of the AI transformation. The notion of machine autonomy has some merits but it needs to be used in a way that makes sense for companies.

CEEMET (Council of European employers of the metal engineering and technology-based industries)

The Commission Communication on artificial intelligence is a very ambitious document. It puts forward a distinct European model for the development of AI.

In the manufacturing sector in Europe, 1.3 million new jobs were created since 2014. These were open-ended and high-paid high-quality jobs. The message that needs to be conveyed is: do not be afraid of changes, be open to them.

Self-employment should be encouraged, as some self-employed people could become the next Jeff Bezos, the founder of Amazon. As regards social protection, we need to be flexible and agile but still keep a high level of protection.

Discussions around the implications of AI on the future of work need to involve all Member States, including the new ones, who are currently not very active.

According to the OECD, productivity in Europe is lagging behind because of the existence of zombie firms.

A key aspect of tackling the current transformation is skills improvement - we have to invest in lifelong learning.

Loss of membership (especially on the trade unions' side) is a problem when it comes to collective bargaining. There are some good developments, for example in Germany (on skills) and in Denmark – where a platform company in the cleaning industry achieved a collective agreement with a trade union. Experimentation is very important here and the Commission should leave breathing room for the social partners to experiment.

When it comes to explaining machine decisions, it is important that humans have the final say on important decisions.

As regards the need to adapt legislation, the AI revolution raises product liability issues but current legislation is relatively appropriate already. As regards the Commission proposal on the transparent and predictable working conditions, an EU-wide definition of 'worker' could undermine start-ups.

UEAPME (European Association of Craft, Small and Medium-Sized Enterprises)

There are 23-24 million SME companies in Europe. They represent frontrunners, innovators spreading new technology, and followers. UEAPME has a different, diverse membership background.

The impact of AI on labour markets will affect tasks rather than jobs. Local jobs, such as the baker or shop around the corner, will stay. Many jobs will still be performed by human beings.

There is a strong regional aspect to the coming changes as we need to avoid regional dichotomies in the EU. Another issue is the concentration of new technologies in cities - large tech companies are based there and that's where talent goes. This creates problems for regional development and rural areas.

It is very important to roll out AI technology to SMEs. Most SMEs rely on larger companies in terms of technology, data and tools. This creates disadvantages. There is a need for a level playing field in terms of data, technology, etc. (small garages do not get access to data from cars for example). The potential for data monopolies is very problematic for SMEs.

European social partners have a good understanding of the fact that education systems need to change. However, there is reluctance in the education systems to do so.

On the governance of lifelong learning and skills - for SMEs, tailored offers on the organisation and timing of trainings are needed. There have been experiments carried out in Sweden on how to organise continuous training - defining responsibilities, who pays for what, etc. It should work similarly to the pension system - layers of general skills relevant throughout one's life should be financed by the government, while job-specific skills should be financed by employers.

On regulation - some of the regulation prevents things from happening. Multinationals make decisions on where to establish themselves based on certain national conditions. Facilitating entrepreneurship and self-employment in this regard is very important.

EFAA (European Federation of Accountants and Auditors)

The accounting industry is already facing the challenge of cross-industry competition from banks doing accounting by using AI. There is a lot of fear in the accounting profession about people losing their jobs. One big problem is that many companies lack AI skills, and are too small to hire experts to advise them about the digital revolution. In addition, the smallest accounting firms do not see what is happening around them and continue to operate in the traditional way.

By using AI, 30-40 % of the traditional accounting profession will be automated soon. An important question to ask is: what will happen to the people who lose their jobs? A general trend in the sector is many people starting their own companies as self-employed. AI deployment is thus leading to the transformation of work towards more self-employment.

CEEP (European Centre of Employers and Enterprises providing Public Services and Services of general interest)

In the public administration sector, there is a risk of established rules being replaced. These rules can be replaced by automated processes that learn by data – machine learning. The ability to collect data for all types of sectors - electricity, public administration, train operators, etc. - can affect employment in these sectors. Digitalisation is accelerating this and creating efficiency gains - more and more statistics are being collected.

In the future, with more and more data, the potential for automation in public administrations will grow. A key question is: how do we innovate using the data available in the public sector?

Job evolution is more about the OECD's task-based approach than about jobs disappearing. This means that some tasks will be transformed but most jobs will not disappear. This is something that should be taken into account in social dialogue, especially at sectoral level.

More and more public services are being digitalised - in Estonia for example. People who do not have digital skills will be cut off from public services if we do not address this.

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