Mutual Learning Programme

DG Employment, Social Affairs and Inclusion

Thematic Discussion Paper

Digitisation and work: how governments are responding to changing labour markets?

Seminar

"Work 4.0 digitalisation of the labour market"

Czech Republic, 28 February 2018

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1 Executive Summary

In this input paper for the seminar on "Work 4.0, digitalisation on the labour market" (28-02-2018), we discuss the impacts of new technological developments (e.g. robotics, automation, artificial intelligence) on the labour market. While we focus on labour and the consequences of technology for labour markets, we include the anticipated impacts of technology on related (policy) areas, such as education, finance, social, and (to some extent) legal.

First, we discuss the broader nature of newer technological developments and their impact on societies as a whole. While most publications and experts disagree about the exact impact of technology on society, most do agree that we live in an era of far-stretching technological change. Dubbed by some the "fourth industrial revolution" or the "second digital age". There seem to be some consensus that: a) **the speed of technological change is increasing**, b) **technological changes are interacting profoundly with societies**, and c) **it seems certain that big (societal) changes are underway**. General policy implication is that policy makers (and governments in general) need to closely monitor technological developments and anticipate its consequences.

Second, we focus on the impact of technology on work. While not many publications explore the broader societal impacts of the current wave of technological developments, a significant body of work focuses on the impact of technology on the economy and labour markets. While some take a critical stance and assert that the actual impact of technology is yet to be seem, the majority of views suggest that the **impact of the new wave of technologies is expected to be so profound and impacting so many policy areas that positive impacts in one area could easily be offset by negative impacts in other areas**.

Regarding the impact of automation on work, most publications focus on one (or a combination) of three scenarios:

- Loss of jobs through automation and replacement of workers by robots,
- A shift in working arrangements where workers work less and/or more flexibly,
- The creation of more jobs and/or new types of jobs due to automation.

Regarding **loss of jobs through automation**, we draw the following conclusions:

- Estimates of the number of jobs lost to automation vary strongly. The only consensus is that jobs will be lost. Our estimate is that the number of jobs lost will progress in time as capabilities of robots increase.
- Perhaps a better perspective is to look at the number of 'tasks' that can be automated rather than number of jobs. This will probably imply that:
  - Certain jobs disappear because all tasks within that job can be automated and it is cost effective to do so.
  - Many jobs will be affected, because tasks within jobs will be automated. For certain jobs this will increase productivity. For other jobs it means that a) either positions will be merged if big parts of the job can be automated or b) more people will end up in different types of work arrangements.
- Jobs and/or tasks that are least at risk are a) those not cost-effective to automate and b) those tasks difficult to automate because they are non-repetitive, too complex and/or deal with high levels of ambiguity.

Regarding the **shift in working arrangements,** we expect the impact to be more profound and conclude that:

- There is a longer ongoing trend of workers having alternative work arrangements (AWA).

- This trend is expected to continue due to automation, making it likely that more workers will end up with AWA.
- This could have (underestimated) consequences in terms of worker’s social security, benefits, but also the value they derive from being part of the workforce.

Lastly, we expect that automation will also lead to **job creation**. In some cases this implies an expansion of jobs in already existing categories, but it is also likely that new types of job categories will appear. What is important to note is that most (new) jobs require different skills sets than are currently abundant in the labour market.

Third, we focus on the impacts of technology on education, finances and social aspects. Regarding **education** we expect that, if automation does disrupt labour markets, its effects on education will be as disruptive. In the more pessimistic scenarios, large groups of students are (already) in programs that train them for jobs that no longer exist when they graduate. The effect on the nature of education appears to be twofold:

1. The first is the need to change educational programs for students. The emphasis should shift from the more traditional knowledge based education to skills that fit the future.
2. The second is the need to focus more on life-long learning as technological developments will continue to impact jobs and skill requirements.

Educational programs should be tailored to fit the future and should focus on a) human literacy skills, b) experiential learning, c) engraving a mindset of life-long learning and d) digital skills. In addition, further technological developments emphasise the importance of STEM education.

The ongoing and possible accelerating replacement of human labour with robots and other technologies could have far reaching **financial consequences**:

- We already witness a shift in (national) income from labour to capital and this shift could accelerate. As a result, taxable income based on labour could decline. Furthermore, financial inequality could grow and consumption could go down.
- If automation continues, more people will lose their jobs and more people will end up in Alternative Work Arrangements (AWA). More people, thus will rely on income benefits and/or the governmental education system, thus putting further pressure on the system.

Thus, a serious consideration for policy makers is how the current (governmental) financial system will remain sustainable.

Lastly, regarding the **social aspects** of automation, automation could:

- Lead to greater social inequality, driven by financial factors, but augmented but people's social status and power derived from their jobs.
- Create a reinforcing (spiralling) effect whereby the remaining high skill (and highly waged) jobs favour people from higher socio-economic backgrounds.

Next, we turn to (potential) plans and initiatives. It appears that, while certain countries are developing comprehensive plans and/or stimulating serious dialogue around the future of work, we also observe that:

- **No single country appears to have broad ranging plans in effect** that encompass all relevant policy areas. In most countries, the longer term plans are under development, in earlier stages, or non-existent.
- When countries are developing broader or more ambitious plans regarding automation, they **focus on the economic aspects** of automation, predominantly centred around a) the question how the country’s economy can remain competitive and b) what is required from the labour market to satisfy that goal.

Furthermore, several countries are developing targeted policies that could help address some of the challenges raised by automation. Most of these seem to be aimed at a) stimulating life-long learning and/or education in general, b) legal and ethical rules for robots and c) some thinking about the financial aspects of robotisation such as a robot tax and/or universal basic income. Social reform appears to be lower on the agenda and it appears not many countries are developing policies at all.

2 Introduction

Headlines of media outlets around the world mention something related to technology[1] on almost a daily basis. Most recently, American private space company SpaceX generated a flood of attention when launching a car in an orbit around the sun using a self-built rocket in the first week of February 2018. More broadly, almost every day we find articles in the news about bitcoin or other cryptocurrencies, blockchain, artificial intelligence, big data, virtual or augmented or mixed reality, or any other new technology. It appears the arrival of new technologies has taken such pace and impact on society that some argue a new era in human technological evolution has begun. Some label this "The Second Machine Age" (Brynfolfsson & McAfee, 2016), others call it "The Fourth Industrial Revolution" (Schwab, 2016). Although the labels are different, the underlying analysis and expected consequences tend to be similar and suggest a number of important developments:

The first is the **speed of technological change**. Technology is evolving quickly and some argue the speed of technological change is increasing. For example, Moore's Law[2] (which has been more or less come true in the past 30 years) predicts that the capacity of computer chips doubles roughly every 18-24 months. The consequences are that a) computer chips become cheaper and more powerful, and b) the doubling results in an exponential development of computational power. The second is that **technological changes are interacting profoundly with societies**, with technologies changing societies and vice versa. For example, technological change has influenced globalisation (by creation global communication networks), but is also driven by globalisation (for example the need for mobile communication and translation services). The third is that the future has become highly uncertain in terms of societal evolution. But **it seems certain that big changes are underway**. While some argue that the forces of technological innovation are unstoppable and progress is inevitable, others challenge this assumption (Mansell, 2017). They argue that the degree of change is contingent upon social, political, and economic factors. As a result of the expected, but uncertain changes, Schwab (2016) argues that "all stakeholders of global society – governments, business, academia, and civil society- have a responsibility to work together to better understand the emerging trends" (p. 2).

Regardless of the exact impact of technology on the future, many agree that labour markets can expect changes in the coming decades. Previous 'waves' of technological innovations (e.g. The steam engine in the 1800s, computers in the 1960s) have led to massive changes in employment and as such experience teaches us that changes are to be expected.

But which changes, and what to do? These questions remain, even as a flurry of books, reports, and other publications on the matter have been published in recent years. To discuss these questions and help member states prepare for the future, the European Commission is organising a seminar on "Work 4.0, digitalisation of the labour market" (28 February 2018, Prague). This paper serves as an input for this seminar. Its goal is to provide an overview of the current state-of-the-art in research, theory and practice with regards to a) the expected (near) future impact of technology on labour markets and employment, b) impacts beyond work that are important for policy makers and c) current policies as planned or deployed by governments or recommended by experts to prepare for the future.

This paper is divided in four chapters. The first summarises the current predictions regarding the impact of technology on work, as well as the consequences for labour markets. The second discusses the wider implications for policy areas that are related to labour (such as education). The third discusses current policy plans and recommendations and the fourth and final chapter contains the main conclusions.

[1] In this paper we take a broad perspective on the impact of technology, this broadly encompasses digitisation, robotics, automation and artificial intelligence. We use these terms (as well as synonyms and derivates) interchangeably, unless specified.

[2] Named after Gordon Moore, co-founder of Intel, also see https://en.wikipedia.org/wiki/Moore%27s_law

3 Digitisation and work

In this chapter, we discuss the background, developments and consequences of digitisation on work. We first briefly (2.1) discuss the broader background of technological developments and how these have changed labour markets. Subsequently we discuss the (anticipated) impact of this current wave of changes on the labour market (2.2). The focus thereby lies on the short to mid-term changes (5-20 years).

3.1 Background

Technological change is nothing new, after all one could argue the invention of the wheel and the ability to make fire with tools constitutes technological innovation. However, many equate the start of the technological age or the 'modern period' in human evolution with the invention and perfection of the steam engine in the 1800s. This first industrial revolution led to large-scale mechanization of labour and even though it might have cost certain people to lose their job, unskilled workers have been the greatest beneficiaries of the Industrial Revolution (Clark et al., 2008). Main reason is the rapid increase in production, wealth and consumption, creating simply more demand for labour. The second industrial revolution started in the late 19th century and lasted through the early parts of the 20th century (Schwab, 2016). Its drivers were the invention and diffusion of electricity and the assembly line. It allowed for specialisation and, once again, massive increases in productivity. This period did coincide with large social changes (e.g. universal voting rights, suffrage, unionisation and the introduction of many social policies), but once again it mostly led to more demand for labour and an increase in productivity. These first two industrial revolutions are what Brynjolffson and McAfee (2016) label the "first machine age". The third industrial revolution, according to Schwab (2016) and second machine age (Brynjolfsson & McAfee, 2016) started in the 1960s with the advent of computers. This was followed by periods of miniaturisation (personal computers and handhelds), the advent of computer networks (the internet) and mobile computing.

A key difference between this third industrial revolution and the previous ones is that it no longer impacts just blue collar work, but white collar work as well and as such technology is now impacting every segment of the labour market. Throughout the 1960s until the late 1990s productivity increased and technology aided in raising living standards and wealth through the more advanced nations.

Now we are at the dawn of what some label the 'Fourth Industrial Revolution' (Schwab, 2016). Schwab (2016, p. 3) argues that three reasons explain a distinct, and new, revolution is under way:

- **Velocity.** As opposed to previous changes, this one is evolving at exponential, rather than linear speed.
- **Breadth and Depth.** This revolution builds upon previous revolutions and is characterised by the combination of technologies that will lead to drastic shifts in the economy, business, society, and individually.
- **Systems Impact.** It entails the transformation of entire societies (instead of segments), across and within countries, systems, companies, industries, etc.

In similar vein, Brynjolffson and McAfee (2016) argue that the three key characteristics of the current period can be described as *exponential, digital,* and *combinatorial* (p. 37), which broadly refers to similar developments. Several technologies underpin the fourth industrial revolution and some examples are:

- Autonomous vehicles and other (semi)-autonomous objects (e.g. drones).
- Advances in material manipulation (e.g. 3d printing).
- Hardware automation and advanced robotics (e.g. warehouse and household robots).
- Software automation and artificial intelligence (e.g. intelligent agents, decision-making system and predictive analytics).

- New software and big data approaches (e.g. blockchain, crypto currencies).
- Increased connectivity and networking technologies (e.g. Internet of Things).
- Technology as platforms and the sharing economy (e.g. AirBnB, Uber).
- New computational approaches (e.g. Quantum computing).

Another moniker, putting the fourth industrial revolution specifically in the context of business is that of "Industry 4.0" (Industrie 4.0 in German), coined in Germany to describe how technology is changing business (Landmann & Heumann, 2016). The label "Work 4.0" could be used to describe how technology is leading to new types of work, working arrangements, employment and the broader labour market as a whole.

While technology and technological change are the driving forces of these "4.0" developments, it would be wrong to focus solely on the technological aspects of current changes. Other changes are happening as well. For example, most advanced economies are at present going through a demographic transition in which the ratio of retired to working population is increasing (Lawrence 2016). Furthermore, factors such as deskilling, flexible specialisation, global division of labour, economic migration, and structural unemployment have all contributed to changes in the labour market (Pitts, Lombardozzi & Warner, 2017). But what changes exactly? This we will discuss in the next section.

3.2 Impact on work

Although it is difficult to assess the exact impact of technology on work, several publications extrapolate from existing trends or theorise about the future of work. This is mostly based on an analysis of job and/or categories, as well as the capabilities of robots and automated systems.

First of all, according to a recent study by the McKinsey Global Institute (2017) automation technologies will severely impact work. They found that 60 percent of occupations have at least 30 percent of constituent work activities that could be automated. However, this does not imply that employment levels will go down: even with automation, the demand for work and workers could increase as economies grow, partly fuelled by productivity growth enabled by technological progress (McKinsey Global Institute, 2017).

Brynjolfsson and McAfee (2016) draw a similar conclusion and argue that as robots become more powerful and capable over time, they can do more of the work that people used to do. Digital labour, in short, can be a substitute for human labour. This happens first with the more routine tasks (both physical and cognitive). This is also part of the reason why less educated workers have seen their wages fall the most in recent decades (also see below) as part of their tasks can be more easily automated.

Brynjolfsson and McAfee (2016) further argue that not all is negative. Their so called second machine age will boost productivity, but this mostly applies to more highly skilled workers (as it will augment their capabilities). Low-skilled and medium skilled jobs would be mostly at risk.

However, there are more critical views that dispute the replacement of jobs by robots. Autor (2015), for example, is asking sceptically, "Why are there still so many jobs?" with the implication that advances in digital technologies may not be as disruptive as is sometimes forecast." Furthermore, it is estimated that three-quarters of potential productivity improvements related to automation come from the broader adoption of best practices and technologies, as companies catch up with sector leaders. Only a quarter is from technological, operational, and business innovations that go beyond best practices and push the frontier of the world's GDP potential (McKinsey 2015). Yet the diffusion of technologies to the non-frontier economy has to a considerable extent broken down, slowing the pace of automation and weakening productivity growth (Andrews et al 2015). For example, across the OECD labour productivity in the manufacturing sector increased at an average annual rate of 3.5% during the 2000s within innovative firms, but only 0.5% in firms that operate behind the innovation frontier. Barriers against this technological adoption include legal and economic hurdles, such as IP law and patents (Haldane 2017). Relatedly, the surge of 'superstar firms' in the digital economy, driven by powerful network effects, could be generating monopolies that dominate the market and hinder innovation and the dispersal of its benefits (Autor et al 2017).

So while, there are optimistic views about the impact of automation on work, there are sceptical or negative views as well. The one thing most of these viewpoints do have in common is the economic angle they take on the matter. Mansell (2017) argues that investments in the development of new technologies is expected by many industry leaders to push development along a singular pathway through the aforementioned fourth industrial revolution, however, alongside the economic measures, "introducing measures that could better address social and economic inequality or the potential for a loss of human authority and control over the workings of advanced digital information processing systems is often seen as unnecessary and damaging" (Mansell, 2017). This is an important realisation, since as we will see below, the **impact of the new wave of technologies is expected to be so profound and impacting so many policy areas that positive impacts in one area could easily be offset by negative impacts in other areas**.

Regarding the impact of automation on work, most publications focus on one (or a combination) of three scenarios:

1. Loss of jobs through automation and replacement of workers by robots,
2. A shift in working arrangements where workers work less and/or more flexibly,
3. The creation of more jobs and/or new types of jobs due to automation.

We will discuss each of these briefly in the following paragraphs.

3.2.1 Job Loss & Replacement

Many studies predict automation will lead to loss of jobs and/or the replacement of workers by robots. One of the most frequently cited (and extreme) is Osborne & Frey's (2013) prediction that 47% of all US Jobs will be lost in the next 20 years. But there are many more studies predicting loss of jobs. For example, in 2016 the World Economic Forum[3] predicted that automation will result in loss of over 5 million jobs across 15 developed nations in 2020. Another, slightly less conservative estimate suggests that digital technologies could replace approximately 140 million full-time knowledge workers worldwide (McKinsey Global Institute, 2013). The International Labour Organization (ILO) mentions a similar number of (approximately) 140 million[4], but in 5 Asian countries only (Cambodia, Indonesia, the Philippines, Thailand, Vietnam). Research Agency Forrester[5], in 2016, is even more conservative and predicts that digital technologies will replace 16% of all workers in the US by 2025. New types of jobs (e.g. in automation) would create 9% more new jobs, but the end result would be a loss of 7% of all jobs. The World Bank (2016) estimates the number of occupations to drop by 57 percent in the OECD in the coming decades.

However, there are more nuanced views as well. In Germany, Dauth et al (2017) found that two workers can be replaced by one robot in the manufacturing sector. However, in the aggregate, automation has not impacted the labour market and the total employment in Germany. But, their analysis also suggests that robots did contribute to the decline of the labour income share (also see below). This is partly due to the willingness of workers to accept wage cuts in order to stabilise the number of jobs in view of the threats posted by robots. A recent OECD study concluded that, when accounting for job-level tasks, only 9 per cent of jobs in the UK are susceptible to automation in the next decade, but that 35 per cent of jobs would change radically in the next two decades (Arntz et al 2016). The Information Technology and Innovation

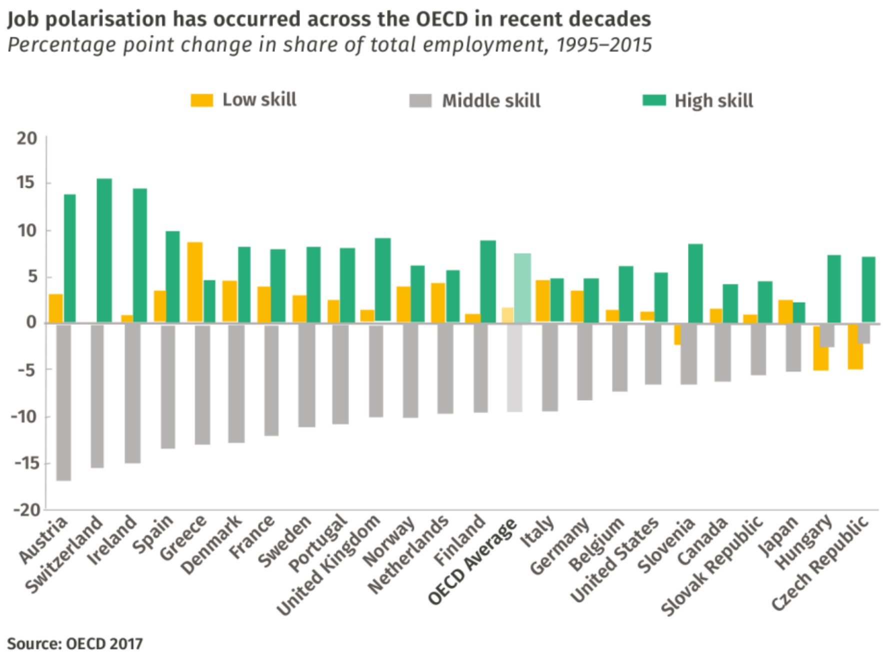
[3] See http://www3.weforum.org/docs/WEF_FOJ_Executive_Summary_Jobs.pdf
[4]See http://www.ilo.org/public/english/dialogue/actemp/downloads/publications/2016/asean_in_transf_2016_r1_techn.pdf
[5] See https://www.forrester.com/Robots+AI+Will+Replace+7+Of+US+Jobs+By+2025/-/E-PRE9246

Foundation (ITIF), also takes a sceptical approach (Atkinson, 2017). Their analysis suggests that existing studies (such as Osborne & Frey's (2013) mentioned above) are overestimating the number of jobs lost due to automation, mostly by a too optimistic view of the 'automatibility' of jobs. The ITIF's analysis suggests that 8 percent of workers are employed in "high-risk" occupations (i.e. Jobs that can be easily automated. Arntz et al (2016) arrive at a similar number and, suggest that only 9 percent of jobs in the OECD can be easily automated. In addition, the ITIF's analysis suggested that employment in the high risk categories will actually increase until 2024 simply due to the higher increase in labour demand.

Many argue that, due to the nature of work that can be automated, the work force will increasingly fall apart in several groups. For example, internet entrepreneur Marc Andreessen is quoted as saying "The spread of computers and the Internet will put jobs in two categories: People who tell computers what to do, and people who are told by computers what to do" (in Brynjolfsson & McAfee, 2016). Only one of these two job categories will be well paid. Goos and Manning (2007) make a similar distinction in Lovely jobs vs Lousy jobs.

Within the same context, the UK Commission for Employment and Skills (Störmer et al. 2014) found that there is a so called "shrinking middle" within the workforce that is at risk and needs retraining or else could be out of jobs. Opposite this shrinking middle is a high-skilled minority (characterised by creativity, analytical and problem solving skills, and communication capabilities) which will have strong bargaining power in the labour market. On the opposite end is a group of low-skilled labourers that will bear the brunt of the drive for flexibility and cost reduction. An illustration of this shrinking middle can be found in a 2017 OECD study (see *Figure 1* below), which shows the change in job types between 1995 & 2015 in OECD countries. It shows how in most (not all) countries there has been an increase in highly skilled jobs and low skill jobs, but actually a decrease in the number of middle skill jobs.

Figure 1: The shrinking middle (OECD, 2017)



However, while many focus on the influence of automation on entire jobs, the McKinsey Global Institute (2017) argues that is wiser to focus on the automation of tasks, rather than entire jobs. This makes sense, as many people's jobs comprise of various different tasks with one being more easily automated. Furthermore, the main focus of automation and robotisation is still on the automation of single tasks. Robots with general (broad range of) skills are non-existent yet and are unlikely to reach the market soon. With the focus on the development of these more 'single task' robots, several of the oft-cited criteria of the task impacting the degree to which they are automated are:

- The degree to which the task is **routine**/repetitive. The more repetitive the task, the more it makes sense to automate it. This makes many factory jobs relatively easy to automate.
- The **complexity** of the task. The more complex the task (i.e. the number of interrelated actions) the harder it becomes to automate. Therefore, relatively straightforward tasks are much easier to automate. Many repetitive and simple tasks have already been automated since the 1970s, for example welding in car factories. At present, this is an area where technology is making much progress, leading to robots being able to handle more complex tasks.
- The **ambiguity and emotional aspects** of the task. This pertains to the uncertainties surrounding a task, for example solving problems with many unclear elements and/or tasks with more emotional components. Managing people for example can be a routine job that is not complex, but dealing with humans can create many ambiguities. Another example is ethical or moral elements in tasks. For example a self-driving car that needs to determine whether to choose to save the people in the car, or the people the car is about to hit.

A common assumption is that it is just low level and low paid jobs that will be automated. While it is true that many of these jobs fit the criteria above and thus are most susceptible to automation, there are also highly paid jobs that fit these criteria, for example certain jobs of surgery or (para)legal work.

While for the job market as a whole, the number of tasks replaced by robots can be expressed in terms of full-time jobs, a more accurate calculation may be that of the number of hours replaced or automated by worker. Several studies already suggest changes in the number of hours worked in recent years. For example, the number of hours worked (per worker) has declined since the 1950s in OECD countries (Lawrence, Roberts & King, 2017). Despite this, the employment to population ratio (the number of people in work as fraction of the entire population) actually increased (Autor 2015). According to McKinsey (2011) both technological change, as well as shifting employment patterns have impacted the changes in productivity, leading to an overall net increase in employment levels in the 20th century. Thus, in the past decades, automation has not had a significant impact on the number of jobs but seems to have contributed to a reduction in the hours worked per worker (Lawrence, Roberts & King, 2017), which brings us to the second scenario, that of the change in work arrangements (see following paragraph).

In sum, it seems we can derive the following conclusions (for now):

- Estimates of the number of jobs (on aggregate) being lost due to automation vary strongly. The only consensus is that jobs will be lost. Our estimate is that the number of jobs lost will progress in time as capabilities of robots increase. While uncertain how many jobs, the number will be significant.
- Perhaps a better perspective is to take a task perspective and looking at the number of 'tasks' that can be automated. Such a perspective suggests that jobs can be replaced if all tasks that comprise a job can be automated, however, a condition to do so is that automating the job is more cost effective than having a human do it. Furthermore, it suggests that most jobs have components that can be automated. This will probably imply that:
- Certain jobs will disappear because all the tasks within that job can be easily automated and it is cost effective to do so.
- Many, if not most, jobs will be affected by further automation. For example because certain tasks within a job will be automated. This implies that:
- For certain jobs (and sectors) this will increase productivity and give people more time to add value.

- For other jobs it means that a) either positions will be merged if big parts of the job can be automated or b) more people will end up in different types of work arrangements (see below), for example by working part-time or flexible jobs.
- Jobs and/or tasks that are least at risk are a) those not cost-effective to automate and b) those tasks difficult to automate because they are non-repetitive, too complex and/or deal with high levels of ambiguity (e.g. Jobs/tasks characterised by creativity, analytical and problem solving skills, and communication capabilities).

3.2.2 Alternative work arrangements

Another angle is that of the shift of working arrangements (often under the Alternative Work Arrangements' (AWA) moniker. Here the argument is that automation is accelerating an already ongoing trend in which more people have flexible working arrangements. For example, people could work part-time and/or only when needed. Yusuf (2017) notes that full-time jobs with generous benefits are becoming fewer. Instead, more people will be in contract employment and on-call jobs of varying lengths. The result is that more people will end up in 'precarious employment', which can be defined as "non-standard employment that is poorly paid, insecure, unprotected, and cannot support a household" (Fudge & Owens, 2016).

A study by the Guardian[6] from 2016 showed that 20% of all workers (7.1 million people) are in precarious positions[7] where they could lose their jobs (at short or no notice). This figure has grown by roughly 2 million in the 10 years due to businesses increasingly relying on self-employed staff or employees on temporary and zero-hours contracts. An analysis from Germany (Brady & Biegert, 2017) revealed an increase of precarious employment in recent decades as well, leading us to believe precarious employment to be on the rise in other EU countries as well. One of the reasons listed (apart from the German specific issue of the reunification) for the increase in precarious employment is the decline in unionization (from 35% in 1984 to 18% in 2013 in Germany). Another reason are policies aimed at making the labour market more flexible and competitive.

Assuming that the trend toward AWA is irreversible, the labour share of income will continue falling, inequality will rise, and more people will slip below the poverty line. This scenario falls (somewhat) in line with the argument above that automation will mostly replace tasks, rather than entire jobs. If automation will replace parts of many people's jobs, but not sufficiently to cut jobs, or merge positions, it is very likely that more people will end up with alternative work arrangements.

In sum, what we are seeing is that:

- There is a longer ongoing trend of workers having alternative work arrangements, in part due to factors such as automation, but also due to globalisation, increases in mobility, decline of unionisation and more flexible laws in the workplace.
- This trend is expected to continue due to automation (also see above), making it likely that more workers will end up with AWA.
- This could have (underestimated) consequences in terms of worker's social security, benefits, but also the value they derive from being part of the workforce (also see below)

[6] https://www.theguardian.com/uk-news/2016/nov/15/more-than-7m-britons-in-precarious-employment
[7] We define precarious employment as a) uncertain and insecure, b) lacking in social protection and the full citizenship rights of employees in stable employment relationships (Kalleberg, 2011))

3.2.3 Job creation

Automation will also create new types of occupations that do not exist today, much as technologies of the past have done (McKinsey Global Institute, 2017). The question though is what types of jobs could be created. Compared to machines humans are still far superior in three skill areas (Brynjolfsson & McAfee, 2016) and perhaps those areas will see new types of job categories:

- One is high-end creativity that generates things like great new business ideas, scientific breakthroughs, novels that grip you, and so on.
- The second category is emotion, interpersonal relations, caring, nurturing, coaching, motivating, leading, and so on.
- The third is dexterity, mobility. Sensing and manipulation are hard for robots.

The UK Commission for Employment and Skills (Störmer et al. 2014) cites evidence that new types of jobs are emerging to fill the middle ground but these have markedly different entry routes and skill requirements. This observations makes sense, many people in jobs that can be more easily automated have need been trained to be creative, emotional and mobile. A key emerging question is the question to which the people within the middle group can be trained to acquire these skills.

Besides the creation of new categories of jobs, it is also possible that we will see more demand in existing job types. The McKinsey Global Institute (2017) suggests that the follow (broad) types of jobs will see an increase in demand in the future (in advanced nations):

- Professionals,
- Care providers,
- Builders,
- Managers and Executives,
- Educators,
- Tech professionals,
- Creatives.

Most of these jobs are the ones that can be characterised by the factors discussed above; less repetitive, more complex and more ambiguous/emotional. In addition, we can expect jobs to persist in those areas where automation is less cost-effective and it is even possible to see an increase in jobs in such areas, due to a) higher consumer demand, or b) jobs related to servicing and maintaining bots.

In sum, experts expect that automation will also lead to job creation. In some cases, this implies an expansion of jobs in already existing categories, but it is also likely that new types of job categories will appear. What is important to note is that most (new) jobs require different skills sets than are currently abundant in the labour market.

4 Impacts beyond work

In this chapter we discuss the impacts of technologies beyond work (but eventually related) that could warrant changing governmental policies. For example, educational reform may be needed to guarantee that a) new workers have the right skills to find jobs and b) existing workers receive training when their jobs change. In this chapter, we discuss the impacts of automation on relevant (adjacent or flanking) policy areas.

4.1 Education and training

While the impacts of automation on the work force and labour market are uncertain, most publications on the matter do agree that automation requires rethinking of the educational systems. For example, Dervis (2015)[8] argues it will be crucial to provide people with a means to upgrade their skills and knowledge levels as technology innovation continues in the future. Furthermore, Infosys (in the Financial Times) argues that right now the time has come to "rethink education and to recast it as a life-long process." This points to **shift in education from life event that happens once, during a phase in life, to a continuous part of life.** However, it is not just the position of education in our lives that needs to change, it is also the format and content of education. Infosys argues that we need to move away from rewarding memorisation and focus instead on curiosity and experimentation. This collides with our analysis above. If we draw the conclusion that the most resistant jobs/tasks to automation are characterised by complexity, non-repetitiveness and ambiguity/emotionality, we need to focus on developing skills that fit these tasks. Curriculums should be organised to encourage creative problem finding and solving, and learning by doing (and trial-and-error). This should be accompanied by mandatory computer science learning and the development of digital literacy. Furthermore, "organisations also need to make life-long learning resources available for employees to enhance skills development. Indeed, they should be required to dedicate a percentage of their annual revenue to re-skilling staff."[9] A publication by the Boston Consulting Group (2017) adds to this and argues that "the need to continuously re-skill and up-skill oneself will raise the cost and time required for education and individual development". An international comparison of countries practices and experiences regarding the changing world of work shows that the increasing importance of technology leads to an increase in demand for Science, Technology, Engineering and Maths (STEM) skills (Hooley & Borbely-Pecze, 2017).

In this context, Aoun (2017) advocates for a new model of learning, labelled "humanics", which should be aimed at the following types of skills:

- **Human literacy skills**. When it comes to absorbing hard facts and knowledge, robots are far more adept than even the smartest humans—we simply can't compete. But, when it comes to skills like creative problem solving, conflict resolution, communication, and the ability to work on a team humans still have the upper hand.
- **Experiential learning**. This should help hone the competitive human edge. We should not just focus on theoretical learning—the kind that takes place in (traditional) classrooms, but also on experiential learning, in which pupils apply their knowledge to novel, real-world situations.
- **Lifelong learning**. Which is needed to keep up with advancing technology. Developing human literacy skills and our cognitive capacities through experiential learning can help create growth mindset, which is needed if one is to become a lifelong learner. This is something Aoun regards as perhaps the most important step to robot-proofing humans. "[A]s machines advance, all people will need to retool, refresh, and advance their knowledge and skill sets on an ongoing basis" (p. 113).

Furthermore, Auon argues that robot-proofing people for success will require multi-sector partnerships. If higher education is to remodel its approach to meet the needs of

[8] https://www.brookings.edu/opinions/a-new-birth-for-social-democracy/
[9] https://www.ft.com/content/5bf845fe-b7c2-11e6-961e-a1acd97f622d

the 21st century lifelong learner, they cannot succeed alone. Universities will have to collaborate with employers to understand the specific demands of the job and the lay of the labour landscape. This partnership could include governments to develop and monitor specific policies towards a) automation, b) education and c) the labour market.

When it comes to the development of digital skills, several frameworks have been developed that can help us understand the types of digital skills needed to successfully navigate the increasingly digital world. For example Van Deursen et al (2016) break digital skills down in five types of skills (see Van Deursen & Helsper, & Eynon, 2016):

- **Operational skills** (being able to operate a computer),
- **Mobile skills** (being able to use a mobile device),
- **Information navigation skills** (being able to find and interpret relevant information),
- **Social skills** (sharing information and curating friendships), and
- **Creative skills** (creating online content).

It is likely these types of skills evolve over time as well, but they serve as a good starting point in terms of rethinking educational programs.

The urgency of rethinking education is illustrated by several studies. For example, a study by Deloitte[10] in 2016 in the Netherlands suggested that around 1 quarter of all students in the Netherlands (286,000 out of 1.1 million students) are in programs training for jobs that will no longer exist in the (near) future. This stresses the need to work on educational reform sooner rather than later.

However, it is not an easy challenge. One consequence of the ongoing technological developments (especially when developments are indeed increasing in pace) is that it creates uncertainties about skill needs. According to the World Economic Forum (2016) do changes in the ways industries work, as well as the (sectoral) balance between industries make it increasingly difficult to predict skills needs (WEF, 2016). Furthermore in practice life-long learning may not be as easy as one might expect. A study by Yusuf (2017) found that “Workers, especially older ones, have proven to be less mobile than economists assumed, less able to upgrade and diversify their skills, and less entrepreneurial”. This resilience to change could prove to be a challenge, which also receives little attention in most publications.

In sum, we can draw the following conclusions:

- If automation does indeed have disruptive effects on the labour market, its effects on Education will be as disruptive. In the more pessimistic scenarios, large groups of students are in programs that train them for jobs that no longer exist when they graduate.
- The effect on the nature of education appears to be twofold:
- The first is the need to change educational programs for students, i.e. the more traditional role of education. Here the emphasis should shift from the more traditional knowledge based education to skills that fit the future.
- The second is the need to focus more on life-long learning as technological developments will continue to impact jobs and skill requirements.
- Furthermore, the content of education needs to change as well. Educational programs should be tailored to fit the future and should focus on a) human literacy skills, b) experiential learning, c) engraving a mindset of life-long learning and d) digital skills. In addition, further technological developments emphasise the role of STEM education.

[10] https://www2.deloitte.com/nl/nl/pages/over-deloitte/articles/286000-studenten-opgeleid-werk-verdwijnt.html

4.2 Finance and taxation

If robots replace humans in many, if not most, jobs, how will that affect the state's finances especially if a) more people become unemployed and thus drawing (in most nations) unemployment benefits and b) taxable income is going down? Several thinkers in the field, including Bill Gates, Elon Musk and Stephen Hawking[11] argue that the solution to the problem is to introduce taxation on robots in a fashion similar to which human labour is currently taxed. Last year, South Korea was the first country in the world to actually impose a "Robot Tax"[12]. However, this is not a tax on robotic labour, a measure to "downsize the tax deduction benefits that previous governments provided to enterprises for infrastructure investment aimed at boosting productivity". Thus it limits benefits for innovative companies, rather than directly taxing robots. As far as we are aware, no EU country is actively implementing or considering robot taxes.

The question of human labour being replaced by robots is part of the broader development of the shift of labour to capital in macro-economic developments. An analysis of macroeconomic factors (Karabarbounis & Neiman, 2014) has shown that since the early 1980s the share of labour in total income has declined (in a majority of countries), mostly due to advances in information technology. Similarly, in Europe productivity increased by 80.4% between 1973 and 2011, but the real hourly compensation of the median worker went up by only 10.7%.[13]

Technology plays an important role in this change. Efficiency gains in technology have induced companies to shift expenditures from labour towards capital. As long as the overall economy is growing, this should not be a problem in terms of the state generating enough income from labour taxation. However, this does lead to a number of questions for the future; with the new advances in technology and the 'rise of the robots', to what extend can we expect this trend to continue, stall or accelerate? Furthermore, if this development continues and the decline in the share of labour outpaces the growth of the economy, to what extend will this result in a drop in governmental income through taxation?

Brynjolfsson and McAfee (2016) label this trend "The great decoupling". And they argue that productivity growth and employment growth started to become decoupled from each other at the end of that decade. Adjusted for inflation, the average American household now has lower income than it did in 1997. Wages as a share of GDP are now at an all-time low, even as corporate profits are now at an all-time high. However, it is not solely happening in the United States. In Sweden, Finland, and Germany, for instance, income inequality has grown over the past 30 years, though not as high as it has in the United States[14].

Brynjolfsson and McAfee argue that this great decoupling will accelerate in the future, for two reasons:

1. Technologies become cheaper (fuelled by Moore's law), continuously shifting the point where it becomes cheaper to replace human labour with automated labour.
2. Technologies become more powerful, thus enabling the substitution of more complex types of human labour with machines.

The result is growing (financial) inequality. Those with high level jobs and benefiting from capital based income get more, but people living from wages get relatively less. This trends, if continuing and even accelerated by technology could have far reaching consequences. First of all, too much concentration of income and wealth in the hands of the top 5 percent could starve the economy of demand (Yusuf, 2017), as fewer people might have the means to drive consumption and the consumption propensity of people with high incomes is lower than the average. Second, welfare, medical, pension, and

[11] See https://en.wikipedia.org/wiki/Robot_tax
[12] http://www.telegraph.co.uk/technology/2017/08/09/south-korea-introduces-worlds-first-robot-tax/
[13] http://www.epi.org/publication/ib330-productivity-vs-compensation
[14] https://hbr.org/2015/06/the-great-decoupling

unemployment benefits already have become more burdensome, especially in light of aging populations and rising dependency ratios. This could become (much) worse in the future, especially if automation leads to an increase in benefit dependencies and future people that earn taxable income.

According to one analysis (Yusuf, 2017), very few (advanced) countries currently have the fiscal room to improve benefits and tackle the rise in benefit demand. This calls for a rethinking of financial and social policies that should focus on revenue mobilization and rethinking how best to deliver essential services and minimize the incidence of poverty. One key aspect of this is growth. After all, revenue mobilization and income redistribution are a lot easier when the overall pie is growing. However, this hinges on the nation's ability to find successful ways to extract income from capital and balance expenditures. One recent simulation suggests that as the cost of automation decline, income inequality could increase. Solutions could be the taxation of robots and an increase in income tax, but the implementation hurdles of this could impact the overall feasibility of this plan (Guerreiro et al. 2018).

In sum, the ongoing and possible accelerating replacement of human labour with robots and other technologies could have far-reaching financial consequences. The most important are:

- We already witness a shift in (national) income from labour to capital and this shift could accelerate. As a result, taxable income based on labour could decline -relatively- wages have gone down in recent decades. As a result, inequality could grow and consumption could go down.
- If automation continues, more people will lose their jobs and more people will end up in Alternative Work Arrangements (AWA). More people, thus will rely on income benefits and/or the governmental education system, thus putting further pressure on the system.
- Thus, a serious consideration for policy makers is how the current (governmental) financial system will remain sustainable. Steps such as South-Korea's robot tax are only small steps towards rethinking governmental finances.

4.3 Social and cultural

A third type of consequence, after education and finances, focused on the social (and cultural) aspects of automation. While not the focal point of studies on automation (the majority focuses on the economic aspects), some publications do mention social factors.

For example, above, we already mentioned the potential increase in equality caused by automation. This inequality extends beyond financial factors. A recent study in the UK observes that the key challenge of automation is most likely to be in distribution (of wealth) rather than production. If the benefits are shared equally, automation can aid in an economy where prosperity is "underpinned by justice, with a more equitable distribution of wealth, income and working time" (Lawrence, Roberts & King, 2017). However, there is no guarantee this will happen. If executed poorly, automation could create a 'paradox of plenty': society would be far richer in aggregate, but, for many individuals and communities, technological change could reinforce inequalities of power and reward (idem). In similar vein, the UK Commission for Employment and Skills (Störmer et al. 2014) argues that the increasing polarisation in the workforce will result in growing social inequality. Furthermore, developments affecting the labour market, such as technological innovation, tend to affect the worker in three different ways (Castle, 1995):

1. The social status of the worker
2. The role that work plays in the individuals' identity;
3. The worker's standard of living

So, it is not just the financial ways in which automation could affect individuals, but also in the power they hold in society, as well as their social statues. Furthermore, a study about social mobility in the UK (Boston Consulting Group, 2017) found that, social mobility could decrease in the future due to trends such as automation. This could become more problematic. Automation could lead to a greater demand for technical skills, and an increased value of "soft" or "essential life" skills (such as confidence, motivation and communication). This will advantage those from higher socioeconomic backgrounds, who typically have greater opportunities to develop these skills (Boston Consulting Group, 2017).

In sum, if not dealt with, automation could:

- Lead to greater social inequality, driven by financial factors, but augmented but people's social status and power derived from their jobs.
- Create a reinforcing (spiralling) effect whereby the remaining high skill (and highly waged) jobs are those that favour people from higher socio-economic backgrounds.

5 Policy plans and governmental responses

In this fourth chapter we discuss policy plans as they are being discussed and developed by governments and others, with an emphasis on the EU. In the first paragraph (4.1) we discuss broader initiatives as they are being developed and discussed, including more wide ranging policy recommendations by experts. In paragraph 4.2 we discuss smaller initiatives in various domains.

5.1 Longer term and more encompassing plans and suggestions

The most comprehensive response to automation is that of the Industry 4.0 initiative in Germany. Industry 4.0 originates from a project in the high-tech strategy of the German government, which promotes the computerization of manufacturing and building the 'factory of the future'. In it, the German (federal) government worked closely with industry, other governments and relevant stakeholders to analyse and asses the impacts of the current technological trends for German industry. The German government is currently considering various scenarios for the future (execution of which is partially dependent on the new government). A recent scenario study for the German labour market (Landmann & Heumann, 2016) based on the following ingredients:

- Digital Infrastructure (the degree to which Germany is able to create a high quality infrastructure).
- New types of working arrangements (the degree to which the country can create flexible working conditions).
- Digitalisation and competitiveness (the degree to which Germany is able to digitise the economy and be competitive).
- Flexibility and adaptability of the state (the level of flexibility and decision making of the government)
- Polarisation in the labour market (the degree to which labour markets will be divided and inequality will happen).

In March 2017, the German Ministry of Labour (Bundesministerium für Arbeit und Soziales, Abteilung Grundsatzfragen des Sozialstaats, der Arbeitswelt und der sozialen Marktwirtschaft), released another study further detailing the potential future of the German labour market (Bundesministerium für Arbeit und Soziales, 2017). This reports expects no large scale automation of existing jobs, but does expect jobs to change (following the line we discussed earlier). Further, it calls for:

- In the short term, investments in the improvement of qualifications and job/career perspectives.
- Provide more preventive measures (e.g. Think about an insurance to keep people employed, rather than an unemployment insurance)
- Create a right for future employment to guarantee life-long learning opportunities.
- Create more rights and better protections for those in flexible working arrangements.
- Create generally binding collective agreement for social welfare, new models for domestic work and work protection.
- Protect the privacy and guarantee online safety.
- Protect (and expand) social partnerships and (social) bargaining power
- Stimulate start-ups and protect independent works.
- Create a "Personal employment account" that individuals (entrepreneurs) can use to shape their career.

However, while being comprehensive, the Industry 4.0 initiative is mostly focused on harnessing the German economy for the future and strengthening its economy. It is slightly less focused on the social impacts of (future) technological developments. It does address aspects related to education, and unemployment, but much less so the risks of inequality. In terms of actual implementation; there is no plan or policies yet. The ministry advocates an evolutionary process and ongoing dialogue, also about the consequences of automation for the welfare state as a whole.

Another country where a broader and more encompassing discussion is going on, is the UK. The recently unveiled "Industrial Strategy"[15] is based on five pillars:

- Ideas: the world's most innovative economy
- People: good jobs and greater earning power for all
- Infrastructure: a major upgrade to the UK's infrastructure
- Business Environment: the best place to start and grow a business
- Places: prosperous communities across the UK.

While not directly aimed at automation (unlike the German initiatives), the initiative is part of a broader discussion of the UK's (economic) future in the light of Brexit, as well as the changing world of work. This has led to a flurry of activities and recommendations for and by the UK government. For example, the UK council for Science and Technology[16] in 2016 creates 3 recommendations for the UK government economic policies regarding robotics, automation and artificial intelligence (RAAI):

1. Identify challenge areas of economic opportunity and national significance for the UK to improve focus and encourage collaboration.
2. Expand UK demonstrator and translational facilities for RAAI to de-risk commercial investment, provide business and technical advice, cross- fertilise ideas and coordinate activity.
3. Develop UK advanced skills and research capability in RAAI to build critical mass in the science base, the wider translational system and in industry.

The IPPR Commission on Economic Justice In the UK (Lawrence, Roberts & King, 2017) follow this lead and argue that accelerating the pace of automation, as part of the wider adoption of digital technologies across the economy, should therefore become a key goal of public policy. For the UK specifically, this leads to three recommendations:

1. Government needs a clear strategy, allied to serious resources, to support frontier innovation in robotics and artificial intelligence, along with other related fields of industrial digitalisation.
2. There needs to be a dedicated programme to accelerate the diffusion of automation, robotics and other digital technologies throughout the economy.
3. A major national programme should be introduced to equip the UK's workforce with the skills and capabilities needed to complement new technologies.

Furthermore, they go beyond labour market and economic policies. For example, the recommend the foundation of an "Authority for the Ethical Use of Robotics and Artificial Intelligence" to regulate the use of automating technologies." And lastly, in terms of addressing inequality, they recommend that: "New models of capital ownership are needed to ensure automation broadens prosperity rather than concentrates wealth" Lawrence, Roberts & King (2017). However, these recommendation appear to not have been adopted (yet) at present.

In general, most countries are still doing very little to prepare for the future. West (2016)[17] argues that "there has been little public discussion regarding the economic or policy impact of emerging technologies. " (p. 11). In addition, Mansell (2017) points out that "the primary goal of digital economy policy is strongly oriented to promoting

[15] See https://www.gov.uk/government/topical-events/the-uks-industrial-strategy

[16] See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/592423/Robotics_automation_and_artificial_intelligence_-_cst_letter.pdf

[17] https://www.brookings.edu/wp-content/uploads/2016/06/robotwork.pdf

economic growth and competitiveness" (p. 4288). So, while most countries have not developed comprehensive policies yet, and when they do so, it will most likely be oriented towards the economic aspects, as illustrated by the German example. But then what should countries do? Several publications suggest priorities for policies, and the economic aspect is just one of the priorities. For example, the McKinsey Global Institute (2017) describes four priorities for policy makers and business leaders:

1. Ensure economic growth (growing economies create jobs)
2. Skills upgrade (especially retraining midcareer workers)
3. Fluid labour markets (more fluidity in the market, greater mobility, better job matching)
4. Transition support (adapting income and transition support to help workers and enable those displaced to find new employment.

Yusuf (2017) suggests more specific policies regarding the first point (accelerating economic growth):

1. Investment in fixed assets, including infrastructure
2. Improvements in workforce quality (with an emphasis on STEM subjects as well as soft skills)
3. Create policies that reduce the variance in productivity among firms
4. An increase in entrepreneurial activity
5. Well governed urban-environments
6. General purpose technologies (such as electricity and the internet) are key to productivity and growth

However, as argued above, the growth aspect is only one piece of the puzzle. For example, few governments are creating long term plans to ensure stable labour markets, guarantee employee benefits and welfare. Tyson and Mendonca (2015) argue that new policies are needed to provide workers in contingent employment relationships access to benefits, and new institutions are needed to deliver them. They further argue there is growing support for the view that benefits should satisfy at least three conditions:

- They should be portable, attached to individual workers rather than to their employers.
- They should be universal, applying to all workers and all forms of employment.
- And they should be pro-rated, linking employer benefit contributions to time worked, jobs completed, or income earned.

West (2016) mentions several potential (policy) solutions to consider in order to deal with emerging technologies that move beyond benefits and economic growth:

- Uncoupling of benefits from jobs
- Basic income
- Tax credits
- Activity accounts for lifetime learning and job retraining
- Incentives for volunteerism
- Encouraging corporate profit-sharing
- Curricular reform
- Expanding arts and culture for leisure time

In our conclusions, we will elaborate further on the types of policies that could (or should) be developed, but it seems that governments should at the very least start thinking about and planning for the future. The mean reason for this is that in the absence of policy intervention, the most likely outcome of automation is an increase in inequalities of wealth, income and power (Lawrence, Roberts & King, 2017).

In sum, while certain countries are developing comprehensive plans and/or stimulating serious dialogue around the future of work, we also observe that:

- No single country appears to have broad ranging and many policy areas encompassing plans in effect. In most countries, the longer term plans are under development, in earlier stages, or non-existent.
- When countries are developing broader or more ambitious plans regarding automation, they focus on the economic aspects of automation, predominantly centred around a) the question how the country's economy can remain competitive and b) what is required from the labour market to satisfy that goal.

5.2 Specific policies

As discussed above, few, if any, governments have comprehensive plans to address the consequences of technology for their labour market (in narrow sense) and society as a whole (in broader sense). However, several governments are a) looking into potential plans and a) other countries are implementing or experimenting with smaller scale initiatives. In this section, we discuss examples of both. First we discuss labour related policies, next we give some examples of educational policies and lastly we discuss some aspects pertaining to legal and/or financial reforms.

5.2.1 Labour related policies

Several countries have in recent years changed labour related policies and/or are experimenting with new (potential) labour policies. For example, the city of Gothenburg in Sweden is running an experiment with a 6 hour work day for nurses in an old people's home. Results of the experiment suggest it improves staff satisfaction, health and patient care. However, at this point it does not seem cost effective reportedly, the city had to employ an extra 17 staff to help offset the loss of hours.[18] Many countries across the EU are also in the process of increasing their pension ages (e.g. Belgium, Czech Republic, Denmark, Estonia, France, Germany Netherlands and the UK). However, these measures are mostly driven by a) the need for budget reform and b) to tackle demographic challenges (e.g. ageing). We are unaware of any country in the EU having developed specific labour market policies due to automation/robotisation in recent years.

5.2.2 Educational reform

While Germany is considering a Personal Employment Account, the French have recently introduced an "Individual Activity Account" (Compte personnel d'activité, or CPA) (Mahfouz, 2017)[19]. The goal of this Account is to protect and ensure all citizens' professional progress, independent of the changes in their careers. This CPA consists of three elements[20]:

- The Personal Training Account (CPF), which gives (and controls) people at work the right to training and education, thus maintaining a skilled workforce and contributing to goals of life-long learning.
- The Personal Account of Prevention of Difficulties at Work (C3P) which allows employees who are exposed to occupational hazards to log these hazards. These logs can be converted into training or early retirement.

[18] See http://www.independent.co.uk/news/business/news/sweden-six-hour-working-day-too-expensive-scrapped-experiment-cothenburg-pilot-scheme-a7508581.html
[19] http://www.oecd.org/els/soc/19_Mahfouz_French_Individual_Accounts.pdf, also see http://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs_rapport_cpa_final_2.pdf
[20] Also see: http://www.gouvernement.fr/compte-personnel-activite-cpa

- The Civic Involvement Account, recording any voluntary activities. In certain cases these can be converted into training as well.

While not implemented, the IPPR (Dromey et al 2017) in the UK proposed a set of recommendations as part of the 'Skills 2030' programme. These are as follows:

- Provide a 'Personal Training Credit' to support low-paid and low-skilled individuals to invest in their training and career.
- Introduce a 'Personal Retraining Allowance', worth £2,000, for workers who are made redundant and lack an NVQ level 3 to invest in upskilling.
- Develop strong sectoral and local institutions to drive skills policy that reflects the regional composition of current and expected employment and industry
- Establish a cross-government framework to identify and monitor industries in transition as part of the government's new industrial strategy.

In a more general sense, Hooley and Borbely-Pecze, (2017) list a number of types of career development policies - to counter the changing work environment- that are currently being developed or implemented around the world. These include:

- The implementation of national career development strategies to coordinate and improve career development provision and align it to current policy needs (within the EU, in Scotland)
- Privatisation and deregulation of careers and employment services (e.g. Finland)
- Improving access to career guidance services through the establishment of one-stop shops (e.g. Luxemburg), citizens' entitlement to guidance (Austria) or a national careers service (England).
- Embedding career development within the education system (e.g. Denmark, England, Scotland)
- Targeting services to those segments most in need
- Improving the quality of LMI (England)
- Online career development tools (e.g. Denmark, Scotland).

5.2.3 Financial & legal reform

One of the most often discussed financial types of reform (beyond those already mentioned, such as a change in pension age) and focused more directly on the effects of automation is that of a Universal Basic Income (UBI). The rationale is that as robots replace humans in the work place, a UBI can still guarantee an income for everybody. UBI has many proponents. Skidelsky (2015), for example, argues it is time for a basic income guarantee. He argues that as robots increasingly substitute human labour, humans will need an income to replace wages they would have earned from work. He claims that raising the minimum wage will not be effective because it will lower the cost differentials of labour versus machines, and therefore speed automation. To deal with dependency questions, a basic income could be tied to voluntary work or other work requirements.

However, there are opponents as well. West (2016) mentions two arguments against Basic Income: The first is the notion that work adds to (perceived) human (self) worth. Many people derive part of their self-esteem through their employment. Second, there may be a lack of incentive to work when there is an income guarantee (in other words; people may become less productive). Otherwise, people may stop working and do little to contribute to community goals.

While many countries discuss the pros and cons of UBI, Finland is conducting an actual experiment on UBI[21]. In the experiment, a group of 2,000 randomly selected people will

[21] See http://www.kela.fi/web/en/basic-income-experiment-2017-2018

be paid a basic income in Finland. The amount of the basic income is set to 560EUR per month. The experiment is designed to answer the following questions:

1. How could the social security system be redesigned to address the changing nature of work?
2. Can the social security system be reshaped in a way that promotes active participation and gives people a stronger incentive to work?
3. Can bureaucracy be reduced and the complicated benefits system simplified?

The experiment runs for two years (Jan 2017 - Dec 2018), so at present the results of the experiment are not yet known. As far as we are aware this is the only such experiment in the world and no other countries have comprehensive financial policies in place to deal with the consequences of automation.

In terms of legal reform, the status quo is equally scattered. There are some smaller (legal) initiatives. For example, the Saudi-Arabia government changed the law to allow citizenship for robots[22]. Most (current) activity in the legal domain seems to focus on autonomous vehicles and the ethical behaviour of robots. The Ministry for transport and digital infrastructure (Bundesministerium für Verkehr und digitale Infrastruktur, 2017) in Germany published a set of rules or guidelines for autonomous vehicles in June 2017, meant to guide the introduction of automated and autonomous vehicles in the country. In the UK Lawrence, Roberts & King (2017) propose the establishment of an 'Authority for the Ethical use of Robotics and Artificial Intelligence' to provide guidelines and recommend regulatory frameworks for the use and governance of these technologies. The EU is currently establishing a 'European Agency of Robotics and AI' to provide technical, ethical and regulatory expertise to inform regulatory responses to technological developments (European Parliament 2017).

5.2.4 Social reform

Several of the examples mentioned throughout the paper have a social component and could thus be labelled as social reforms. For example, the French CPA is (in part) aimed at guaranteeing the long term inclusive and equal society. It does appear though that very few countries (or publication) cite specific examples of social reform. When policy recommendations are made with a social component they tend to be coupled with financial and educational reforms.

There are some exceptions and they tend to focus on the relationship between labour markets and benefits or social security. For example Colin and Pallier (2015) mention in this context the Danish approach of "flexicurity" as a good approach for the future to combine a more flexible labour market with sufficient (social) security. While not new (and in effect in Denmark since 2007[23]) it is regaining attention as a way to combine flexibilisation and AWA with social security. The essence of flexicurity is the separation of benefits provision from jobs. "If the government can guarantee citizens access to health care, housing, education and training, and the like on a universal basis without regard to their employment status, the argument runs, people won't be so terrified of switching jobs or losing a job. This, in turn, would allow the government to deregulate labour markets, leaving decisions about hiring and firing of employees to be made by firms themselves, according to economic logic." (Colin & Pallier, 2015).

Despite the fact that many publications warn for the risks of greater social inequality, including the loss of power and self-esteem, due to automation, there are hardly any examples of countries addressing these issues, let alone (scientific) publications in this field.

In sum, several countries are developing targeted policies that could help address some of the challenges raised by automation. Most of these seem to be aimed at a) stimulating life-long learning and/or education in general, b) legal and ethical rules

[22] See http://www.independent.co.uk/life-style/gadgets-and-tech/news/saudi-arabia-robot-sophia-citizenship-android-riyadh-citizen-passport-future-a8021601.html

[23] See also: http://denmark.dk/en/society/welfare/flexicurity

for robots and c) some thinking about the financial aspects of robotisation such as a robot tax and/or universal basic income. Social reform appears to be lower on the agenda and it appears not many countries are developing policies at all.

6 Conclusions and points for discussion

Based on the analysis presented in this paper, we draw the following main conclusions (and present these as points for discussion):

- **Robots will replace humans, but the amount is highly uncertain.**
  The first conclusion we draw is that it is hard to assess exactly what that impact is. The estimates of 'number of jobs lost' vary wildly and most of the estimates lack scientific rigour and/or replication. Furthermore, automation will also lead to job creation, whether in existing or new job categories. So while it seems certain there will be job loss due to automation, we should be careful in attributing too much weight to these without more rigorous analysis.

- **Automation will affect most jobs, likely disrupting the nature of work.**
  On the task level, things appear much clearer. It seems that automation will impact nearly every job, but on the task level. For some jobs this could be beneficial, as automation could augment productivity, for other jobs the implication could be that people lose their jobs and for yet others the implication is that the nature of their working arrangement will change. In that, automation could strengthen ongoing trends such as flexibilisation, part-time work, freelancing, job-hopping, etc.

- **Many elements of today's society are not designed for the future of work.**
  Many aspects of our societies are not designed with this change in the nature of work in mind. This applies to educational systems (with education focused on studying as life event and not as life-long activity), benefits (usually being tied to full-time positions), taxation and financial models (based on labour, not capital), and social status (often based on and tied to work success). The consequence is that if we want to prepare for the future of work, we need to think more drastically (and holistically) about societal reform.

- **Policy plans and activities favour economics and labour markets.**
  Most of the thinking, research and exploration of possible policy plans is geared towards the economy. By far the majority of all publications on the impact of automation assess the impact on work. As a result, the main focus of (policy) recommendation lie in reforming labour markets, followed by related areas such as education (as supplier of labour and innovation), finances (as financier) and legal (to facilitate the introduction of new technologies). The primary goal is to become or stay (globally) competitive. Much less attention is paid to the social consequences of automation, such as inequality, social status, etc.

- **Policy development is lagging technological development.**
  Technological developments are going very fast and many argue the speed of technological development is increasing. Compared to that, it appears governmental decision making is struggling to keep up. Even though some technology optimists predict massive disruptions in the labour market in the coming *years,* very few governments seem to be actually planning thoroughly for these disruptions. Given the duration of the typical governmental decision making process, it seems advisable for most governments to start exploring scenarios for the future and prepare fitting (policy) plans that target all impacted areas.

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