EIT Digital

# DIGITAL TRANSFORMATION OF EUROPEAN INDUSTRY

## A POLICY PERSPECTIVE

FULL REPORT

## ACKNOWLEDGEMENTS

In the context of its activities in its strategic innovation area: Digital industry, EIT Digital decided to launch a study focusing on the main policy challenges accompanying the digital transformation of the European industry. The study followed a scenario-based approach to structure and assess the potential impacts of policy measures with a main focus on taxation and labor market regulation. Digital Enlightenment Forum was contracted to execute the study under the guidance of EIT Digital senior staff.

The very nature of the topic of the study and its multi-dimensional context demanded strong involvement by high-level experts for a profound assessment of the different dimensions and their interrelations. We were fortunate to have had such support throughout the study and in particular during the two defining Round Tables and we would like to acknowledge with gratitude the contributions of:

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# EXECUTIVE SUMMARY

In Europe, as in the rest of the world, digital innovation and transformation foreshadow the coming of what has been called the Fourth Industrial Revolution. The concept of Industry 4.0 has emerged to describe this digital transformation in industry in all sectors. Integrating digital innovations in their business strategies is an essential means of creating value and digital integration and connection of systems may create seamless digitalised value chains.

This will revolutionise the structure and governance of markets. But automation and digitisation of production processes will also lead to a significant reconfiguration of work and employment.

The change enabled by technology will give benefits but can also produce negative effects for European economies and societies. Industry 4.0 may benefit certain social groups and/or regions and/or countries, while leaving others behind. In addition, the potential erosion of the tax base due to fewer employed people paying taxes and contributions whilst digital platforms and transactions risk to be elusive to taxation, may seriously challenge the European Social Model and its underlying welfare and social policies.

The objective of this study is to present policy options for the use of taxation and labour market intervention in view of emerging developments in industrial digital platforms, AI and related technologies, and analyse how these options may impact economic growth and social cohesion, as well as the development of Industry 4.0 in Europe.

It is operationalised by considering taxation and labour regulation instruments in terms of their effects on economy, society and politics.

Despite extensive discussions on the impact of AI and robots on the workplace and labour market, there is little systematic evidence. Recent estimates on the effects of automation on jobs show strong variations on potential job losses of between 9% up to 40-60% of current jobs by 2030. The prevalent view is that automation both substitutes and complements human work. But also that traditional full time labour contracts look set to be further replaced by other forms of employment like temporary jobs, freelance work, mini jobs, smalls job intermediated by digital labour platforms etc.

In this report we develop scenarios along two major instrument axes: 1) labour market and social protection measures, 2) forms of corporate taxes.

The analysis shows that policy measures can be designed for a future scenario in between the two extremes of ultra-social and ultra-liberal:

**Ultra-social** attempts turning technological into social innovation by fully transforming the mix between technology, economic incentives and the social fabric. It introduces a Digital Intermediary Tax (DIT, i.e. taxation on the use of digital intermediary facilities), retains R&D machine-related tax incentives, and proposes a new labour market regime (extended flexicurity) where eligibility to benefits for disability, pension and other forms of social care, are independent of the employment status of the person. Increased revenues from a DIT and growth are used to finance the flexicurity regime. This scenario stimulates further social cohesion and is expected to have a positive effect on productivity and economic growth. Though this may be a politically acceptable approach within a country or at European level, the risks are particularly at the geo-political level, as in particular DIT may cause retaliation by geopolitical competitors. This scenario will require strong coordination at the European level and unity of the EU in global or OECD negotiations.

**Ultra-liberal** focuses on stimulating technological innovation and providing economic incentives. It will cut corporate taxes and retain or extend machine-related R&D tax incentives. Social spending does not increase given the labour market regime and there is no reform comparable with flexicurity in the ultra-social scenario. Productivity is expected to increase more than in the other scenario as manufacturing companies invest heavily in technology to substitute workers with machines. Employment in industry decreases and non-standard work increases. Polarisation increases and social cohesion is undermined. Without a DIT and other competition or consumer protection measures the power of incumbent global digital platforms will expand.

These scenarios are both extremes. Reality does not need to be on black and white choices. A smart combination of elements from both, together with policy measures in other areas (competition and consumer protection law, measures influencing labour cost, data sharing regulation, public procurement, industrial policy and other incentives) may eventually lead to a solution that can bring Europe's social, economic and strategic autonomy interests together

**BASED ON THE ANALYSIS IN THIS REPORT THE FOLLOWING COMMENTS CAN BE MADE:**

1. Dependent on the political consensus achieved, a balanced combination of elements from both scenarios can be constructed, creating a labour-friendly environment with technical and social innovation, leading to economic growth and social cohesion.

2. Political consensus could be created by including other measures in addition, for example a strong industrial policy based on investments stimulating European platform development and take up, or new data sharing and competition regulation.

3. Political cohesion internal in the EU is essential to achieve the right balance for Industry 4.0 to produce economic growth and social cohesion with European solutions. InvestEU, Horizon Europe, Digital Europe, and related deployment, capabilities and cohesion programmes in discussion, can support this process.

4. It could be considered to pursue a coalition of labour market decision-makers and innovation/technology policy-makers in Europe to find such balance. EU unity is necessary to manage the global forces in capital and technology, for example through the OECD.

5. If Europe would be pushed to the extreme point of the Ultra-liberal scenario, it is likely that European Industry 4.0 platforms will be marginalised.

6. A balanced transformation can be funded by higher growth, a common higher but selective approach to taxation and if needed, temporary budget deficits.

# INTRODUCTION

## DIGITAL TRANSFORMATION DRIVING INNOVATION AND VALUE CREATION: INDUSTRY 4.0

In Europe, as in the rest of the world, digital innovation and transformation foreshadow the coming of what has been called the Fourth Industrial Revolution. The underlying technological advancements affect economy, society, and personal lives and, thus, the Fourth Industrial Revolution has been characterised as blurring the distinction between physical, digital and biological spheres[1]. This transformation is driven by the ubiquitous adoption of mobile devices, and the development of technologies such as big data analytics, the Cloud, algorithmic management, 3D printing, quantum computing, smart robots, artificial intelligence (AI), the internet of things (IoT), blockchain, and virtual/augmented reality.

Data is the 'fuel' in this transformation, providing the main source of innovation and value creation. The impacts extend far beyond the 'digital economy', with all economic sectors increasingly affected. Data and data analytics will be the main lever of global competition and are becoming indispensable for both public and private organisations[2]. They make possible innovation not just in manufacturing but also in services and, increasingly, a convergence between the two ('servitisation').

The concept of Industry 4.0 has emerged to describe the digital transformation by which industry in all sectors integrates digital innovations within their business strategies as an essential means of creating value. In many European countries, public policies have been put in place to assist companies in this transition[3], and similar policies are being applied in major global competitors such as China[4], the US[5], and South Korea[6]. Although the full digitisation, virtualisation, and servitisation of manufacturing are still at an early stage, Industry 4.0 has caught our imagination both because of the massive potential economic gains and because of its potential impacts on work and markets.

There are various definitions of Industry 4.0, many of which simply list its potential technological components. From a technological perspective Industry 4.0 can be characterised as resting on three pillars: a) Internet of Things (IoT), which allows objects to interact with each other and cooperate with their neighbouring smart components; b) Cyber-Physical Systems (CPS), integrating computation and digital processes where embedded computers and networks monitor and control physical processes; and c) Smart Factories that are context-aware and assist people and machines in execution of their tasks[7]. Digital integration and connection of systems may create seamless digitalised value chains, thus revolutionising the structure and governance of markets. Meanwhile, automation and digitisation of production processes could lead to a significant reconfiguration of work and employment[8]. So-called 'Work 4.0' entails challenges in terms of new skills requirements, unemployment or intermittent employment, and potential polarisation of the labour force. Thus, Industry 4.0 may transform both how jobs are performed (work) and how activities are coordinated (markets).

In this sense Industry 4.0 is not just about Artificial Intelligence (AI) strictly defined[9], but is a collective term for technologies of value chain management beyond firms' traditional boundaries. It is a vision of the seamless interaction of sensors, data analytics and information representation all housed within a single framework designed to continually drive innovation and create value[10]. Industry 4.0 can be defined as the process of automation (through AI and related technologies), digitisation, and data exchange within manufacturing. The main focus of this paper is on the potential impact of the developments in Industry 4.0, both in terms of innovation and efficiency and in terms of employment, as well as its consequences for growth and social cohesion.

## PLATFORMS MUST FUNCTION AS ECOSYSTEMS FOR INNOVATION AND GROWTH

Industry 4.0 is often closely associated with the concept of platform as the conduit for its implementation and development. More generally, digital platforms are an essential and key feature of digital transformation. Whereas the term 'platform' is given different meanings, there is consolidated economic literature on two-sided or multi-sided platforms that are defined in terms of network effects, externalities and how value is created (see a review of this literature in Section 4.1 of the Technical Annex). Initially, the economics of two-sided and multi-sided platforms focussed on payment systems, auctions, operating systems, and traditional media markets. Currently, the main focus is digital platforms with a specific emphasis on implications for competition policy.

From the perspective of economics, the central features of platforms are direct and/or indirect network effects[11]. In platforms 'more users beget more users, a dynamic which in turn triggers a self-reinforcing cycle of growth'[12]. Scale is for platforms both the sign of initial success and the source of continuous future growth. Platforms create value mainly by matching transactions, or facilitating the rise of innovation ecosystems, or both. In their matching function they facilitate and simplify transactions between individuals or organisations that without the platform may have difficulties to find each other. As an enabler of innovation ecosystems, platforms provide the building blocks and technological layers upon which a large number of independent innovators build complementary services or products. Using these two functions and its possible combination the following typology of platforms has been proposed:[13]

- **Transaction platforms** facilitate exchange or transactions between different users, buyers, or suppliers. Typical examples are Uber, Airbnb, eBay, and also digital labour markets matching employers and workers (i.e. Upwork, Amazon Mechanical Turk, TaskRabbit).

- **Innovation platforms** facilitate players loosely organized into an innovative ecosystem to develop complementary technologies and products or services. A typical example is the iPhone, which has hundreds of thousands of applications produced by developers through access to Apple technology.

- **Integrated platforms** facilitate both transactions and the emergence of an innovation ecosystem. The typical example is Apple, which has both matching platforms like the App Store and a large third-party developer ecosystem that supports content creation on the platform. Other examples are Google, Facebook, Amazon, and Alibaba.

Network effects are not exclusive to digital platforms and determined also the success of analogue platforms such as dating clubs, the telephone book, and credit cards. These platforms faced some typical challenges that limited the network effects, such as congestion (i.e. typical for a dating club), the potential scale (limited for the telephone book), and 'Multi-Homing', the possibility for users to be associated with more than one platform and to avoid lock-in (the case of credit cards where consumers could use different systems). Digital platforms potentially avoid all of these limitations and, due to the special nature of digital goods, can scale to dominance through network effects and lock-in and thus create polarisation effects[14]. In view of this potential for monopolistic or at least oligopolistic outcomes, integrated digital platforms are described as a source of concern by legal scholars[15]. These platforms offer services to end consumers and at the same time incorporate vertical and horizontal competitors into their own legal architecture. Some argue they are a form of 'quasi-infrastructure' possibly that should be subject to public utility and common carrier regulation.

In the more technological and industry-oriented literature on Industry 4.0, however, the definition of platforms and their functions takes a different direction and does not focus so much on network effects and possible competition and market structure outcomes. One definition used in a recent report by the EC[16], for instance, emphasises three aspects: a) community role to create connection as in social networks; b) infrastructure role to provide the layers and functionalities that enable users and partners to innovate and create value; c) data role to make data accessible and standardise data processing. The first aspect is about network but in a less pronounced way than in the economic literature on incumbent and large digital platform. The second aspect basically coincides with the innovation role of incumbent and large digital platforms. The third aspect, fundamental for the development of open innovation industrial platforms, is rarely a characteristic of incumbent and giant digital platforms.

Obviously, it is an open empirical question whether Industry 4.0 platforms have the potential for scale to dominance in the same degree has occurred for the integrated digital platforms that currently dominate certain consumer sectors. There are several aspects of the industrial value chains that may limit network effects and scale to dominance, such as differentiation, heterogeneity, and also the fact that vertical and horizontal integration make 'Multi-Homing' likely and lock-in more difficult. On the other hand, one cannot rule out that some of the incumbent integrated platforms may expand into industrial sectors. It is not our role to go deeper into these platform aspects here because of the limited scope of this report, but the broader context of Industry 4.0 and platformisation should be kept in mind.

## SEIZING OPPORTUNITIES AND MANAGING RISKS

The new technological capabilities can trigger innovations in products, services and business models, increasing efficiency, effectiveness and productivity, as well as consumers' welfare and satisfaction. Industry 4.0 can help improve the quality of life of European citizens, while boosting the European economy. European industry could build on its strengths and seize these opportunities. In the more optimistic predictions there will be positive impacts in terms of increased productivity, more revenues, and even more employment as new jobs will more than compensate those lost to automation of production and to digitisation of processes. Furthermore, there is the potential to enhance cognitive diversity and collective intelligence, allowing human workers to do more diverse activities, become more efficient and undertake more creative, fulfilling labour[17]. One could also envisage workers without employers in a system breaking down rigid organizations and internal labour markets and liberating workers' autonomy [18].

At the same time, the impact of the current digital transformation may be uneven at various levels: within a country with social and regional disparities leading to labour market polarisation and soaring inequalities; between large companies and SMEs that may face difficulties in participating in Industry 4.0 supply chains due to costs, risks, reduced flexibility and reduced strategic independence[19]; or between different sectors of the economy.

The growth enabled by technology will give benefits but can also produce negative effects for European economies and societies. Industry 4.0 may benefit certain social groups and/or regions and/or countries, while leaving others behind. In addition, the potential erosion of the tax base due to less employed people paying taxes and contributions whilst digital platforms and transactions are increasingly elusive to taxation, may seriously challenge the European Social Model and its underlying welfare and social policies. The digitalisation of economy and society also profoundly impact upon how our free market liberal democracies function. In sum, there are also risks in terms of social cohesion and of the regulation modes that make the fabric of our society thick[20].

From a European perspective there is considerable risk that most European firms will remain cloud computing service consumers rather than providers. This concern about global level competition is clearly stated in the EC communication on digitising industry[21]. Also the European Parliament (EP) warns that European industry may be forced to adopt and live with standards set by the 'US, Japan, China and South Korea.'[22] Will Industry 4.0 strengthen the EU industry or will leadership be passed to the new emerging economies such as China[23].

Europe must find policy responses that strengthen its industrial leadership and capture the opportunities inherent in the Platform Economy. This report intends to support this process by focusing its scope on two essential policy instruments, namely tax and labour regulations.

# 1. OBJECTIVES AND APPROACH

The current digital transformation has developed so far in a quasi-anarchic fashion, often in areas not fully regulated, thus creating many faits accomplis, including the use of data and market structure, as well as forms of businesses and employment. New challenges have arisen which leave both policy makers and business leaders struggling to find optimal solutions. In the process of digital transformation Europe tends to be on the demand side in many domains, whereas the US and China are in the supply side.

The objective of this study is present policy options for the use of taxation and labour market intervention in view of emerging developments of industrial digital platforms, AI and related technologies, that would stimulate Industry 4.0 in Europe and in so doing create economic growth and social cohesion.

It can be operationalised by considering taxation and labour regulation instruments in terms of the following dimensions and questions:

1. **Economy.** The balance between labour and capital within manufacturing firms, given how companies will specify their set of tasks in view of emerging technological innovations (i.e., automation, robotisation, digitisation). Can interventions spur innovation without radically disrupting employment or create neutrality in the choice between machine and labour without hampering innovation? What effect can these instruments have on the market structure and geopolitical competition (also in relation to platformisation)? What interventions can preserve diversity, competition, and innovation and reinforce Industry 4.0 in Europe?

2. **Society.** Is social cohesion threatened, for example by polarisation in access to employment, two-tier labour markets with sharp gaps between workers in standard work and those in Non-Standard Work (NSW), wage differentials and inequality and access to welfare benefits?[24] Can interventions mitigate crises in the regulatory set-up that may be produced by technical change? Can we increase fairness in our socio-economic systems?

3. **Politics.** What are the implications for political stability and related risks, including geopolitical and global competition aspects of current and future digital transformation and innovation? Can policy interventions with the chosen instruments mitigate such risks?

In the pursuit of the aim of the study, a methodology combining secondary source analysis and interaction with experts was adopted. A very comprehensive scoping review was performed that brings together the scientific literature with a vast array of other sources (industry reports, policy documents, etc.)[25]. Policy scenarios have been developed using the two chosen policy instruments: taxation and broadly-defined labour markets interventions.

# 2. TRENDS AND PERSPECTIVES: OPPORTUNITIES AND RISKS

Utopian and dystopian narratives surround the heralded advent of AI and Industry 4.0, as has often been the case with technological innovations over the past 300 years. This section presents an overview of trends and current debate from economic, social and technological perspectives

In Section 2.1 the limited information and stylised facts on current trends are summarised. Then in Section 2.2 the main perspectives and hypotheses on the effects on the workplace are considered (this is complemented by the Technical Annex), followed in Section 2.3 by some more speculative discussion of the possible evolution of coordination mechanisms. This is concluded in Sections 2.4 and 2.5 by a summary overview of, respectively, main opportunities and risks.

## 2.1 TRENDS

**Automation and digitisation have yet to reach the mainstream and the evidence base on their socio-economic impacts is patchy:** Despite extensive discussion on the potential impact of AI and robots, there is almost no systematic empirical evidence on their economic effects. This should come as no surprise as the full-blown harnessing of AI and robotics is yet to take place. AI, machine learning and smart robots are expected according to the Gartner Hype Cycle to have widespread adoption in both industry and services within the next 10 years[26]. However, there is still a gap between expectation and implementation possibly due to lack of adequate Technology Readiness Levels[27] (i.e. the level of applicability of the technology) and of the investments required[28]. According to analyst Roland Berger, for Europe to catch up with its global competitors and maintain its status as an industrial power, European companies need to invest around €1.35 trillion into Industry 4.0 over the next 15 years (i.e. €90 billion per year)[29]

Data from World Robotics 2016 and 201730 show that at a global level most industrial robots are present in the automotive sector. An EC report (2016)[31] discussing the use of industrial robots in Europe found that, while almost half of manufacturers of rubber and plastic products and manufacturers of transport equipment already use industrial robots in their production processes, only one out of five in the textile industry did so[32]. The countries in the EU with the highest number of industrial robots per 10,000 employees in manufacturing 2012 were Germany, Sweden, Italy, Spain and France.

**European firms have yet to fully embrace new digital technologies:** In a recent survey of EU businesses, 75% of respondents said they regarded digital technologies as an opportunity, but over 41% had yet to adopt any of the new advanced digital technologies[33]. Deficiencies in resources and effective engagement of SMEs are important barriers to adoption, as are scaling up and imbalance between governance levels and different industrial and sectoral interests. Lack of capacity and weak planning and monitor mechanisms are other barriers[34]. In Europe only 6% of ICT and professional

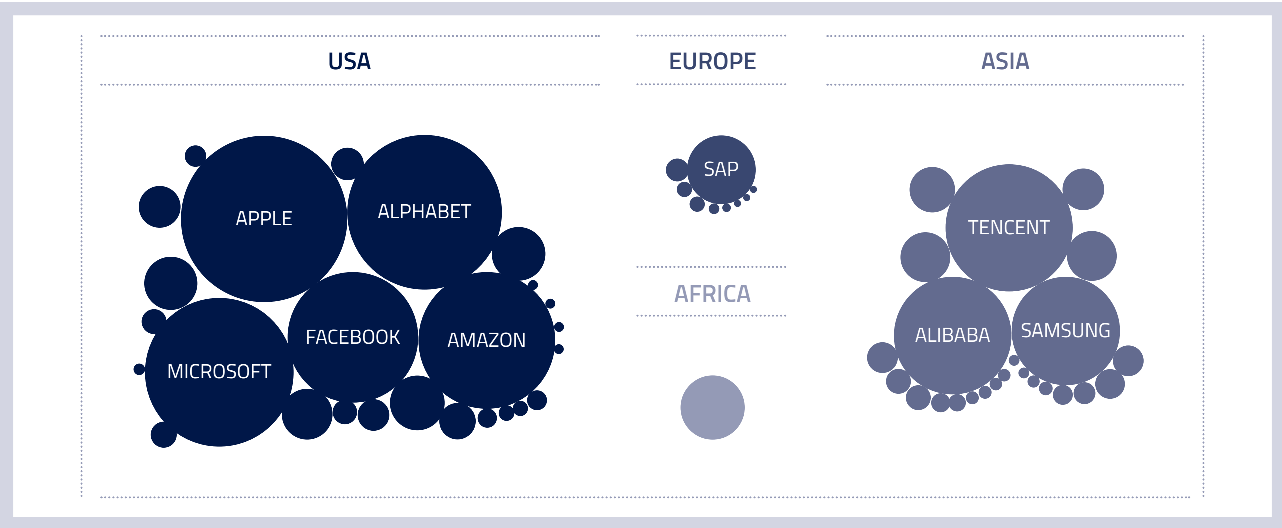



FIGURE 1: Platform economy: Europe lagging behind (bubble size: market capitalisation as of December 31, 2017; source: platformeconomy.com, after Evans and Gawker).

services companies are making strategic and intense use of data, and data specialists are less than 1% of employed personnel[35]. More than 50% of all data centres in OECD countries are in the US[36] and limited access to data and data analytics will make it difficult for European companies to compete in global markets. In general, there is still little awareness about Industry 4.0 outside a key group of stakeholders[37]. A 2015 monitoring report of the German Federal Government indicated that in Germany, the first country to launch an Industry 4.0 policy initiative, adoption of advanced digital technology was low and expected to continue to be so at least until 2020[38]. The same year a survey among German firms by the ZEW (2015) showed that only 18% of all firms are familiar with the concept "Industrie 4.0" . Another survey shows that 90 per cent of the members of the Federation of German Industries (Bundesverband der Deutschen Industrie) recognise the great challenges posed by Industry 4.0 for the future, but only 12 per cent feel prepared[40].

**Europe lags behind the US and Asia in digital platforms:** In Europe there are currently many policy initiatives and projects in the domain of Industry 4.0 platforms spanning several sectors, from smart factories to healthcare, and agriculture. Yet, these are still at an early stage of developments and there is an insufficient evidence base from which to extrapolate basic trends[41]. A global survey of platforms by Evans and Gawer shows that the largest transaction, innovation, and integrated digital platforms currently originate mostly in the US and Asia[42]. This is based on their typology of integrated platforms including both transactions and innovative production. The result (see Figure 1) shows a clear dominance of US and Chinese platforms and very marginal roles played by European ones.

In the Introduction the differences were explained between these end-user oriented platforms and potential Industry 4.0 platforms. Industry platforms may become successful in Europe, but it cannot be ruled out that some of the incumbent end-user platforms may expand into industrial sectors also in Europe. It was for this reason that European Commissioner Günther Oettinger warned at an industrial conference in 2015 that Apple's plan to move into car manufacturing represented a huge threat to the European automotive industry, because it would be Apple that designs the car and provides its information systems, whereas European manufacturers might become only suppliers of metal parts[43].

Aside of geo-political concerns, from the perspective of future European industrial growth, it is important that Industry 4.0 platforms create an open and pluralistic innovation ecosystem, avoiding the risk of market closure. Given European industrial strength, open innovation is a main guarantee of growth.

## 2.2 WORKPLACE

**Estimates of the quantitative effects of automation on employment are uncertain and highly contentious:** One aspect that has attracted significant attention is the extent to which technologies such as AI and robotics will reduce the overall number of jobs. This issue is not confined to manufacturing, since service sectors too are increasingly exposed to AI-based innovations. The available estimates are still very uncertain and differ widely both in academic and non-academic reports (see more in Section 4.5 of the Technical Annex). They range from the risk of computerisation of 47% jobs in the US estimated by Frey and Osborne[44] to only 9% of job loss in OECD countries projected by Arntz et al[45]. Or from 57% of job losses in OECD countries according to Citi Bank and Oxford University[46], to the 14% estimated by OECD researchers[47]. Recent compilations[48] of estimates on the effects of automation on jobs renders this variability very clearly, with a difference of an order of magnitude. For example, worldwide estimated jobs losses by 2030 range from between 400 and 800 million according to McKinsey[49] up to the 2 billion projected by futurist Thomas Frey[50].

**Effects of automation on productivity and growth could be significant**: A blossoming debate on the effects of robotisation on productivity and growth, and especially on employment and inequality currently engages economists, policy analysts, and media commentators. Are we really nearer to a singularity cusp with AI surpassing humans than we have ever been before in history? The media have revived the 'technological singularity thesis' originally formulated in the 1950s and popularised in a best-selling book in 2005[51]. The singularity occurs when an intelligence explosion creates machines far surpassing all human intelligence, leading to full substitution of human workers by robots and to unprecedented growth rates.

According to mainstream economic analysis the advent of a singularity seems unlikely[52] and it is noted that all previous expectations and predictions that technical change would cause long term structural unemployment have so far proven wrong[53]. The prevalent view among economists is that automation both substitutes and complements human work; as some tasks are digitised and workers displaced, new tasks emerge where human labour has an advantage (see § 4.1 of the Technical Annex). Various compensation mechanisms reduce the possibility of structural long-term technological unemployment (i.e., through decrease in prices, wages, productivity gains making use of labour more cost-effective, introduction of new products, new investments, etc.)[54]. The result of the ongoing automation is not clear yet and will depend on the long-run rental rate of capital relative to wages (only if it is sufficiently low would the long-ruw n equilibrium involve all tasks being automated). These models, however, recognise that in the short term some negative effects may occur (unemployment, job polarisation, wage inequality) and affect workers with low skills or performing routine tasks, as the new jobs created by technological innovation will require new skills.

**While the most extreme predictions can be discounted, current indications give cause for concern:** Leaving aside the Singularity thesis, the question remains whether the Fourth Industrial Revolution will be so radical as to overturn the optimism one could derive by looking at the past. In the last twenty years we have witnessed several patterns that may support the emergence of a more worrying scenario such as: a) de-industrialization; b) stagnant wages and divergence between productivity growth and wage growth, c) declining labour force participation, d) soaring inequality and job polarization; e) growing fragmentation and casualisation of work.

**Current trends towards fragmentation of work may be compounded by the further digitisation of economic activities.** Traditional full-time labour contracts look set to be further undermined[55]. A report by Eurofound identified various new and/or alternative forms of employment, including temporary contracts, freelance work, mini jobs, vouchers, 'zero-hour contracts', and small jobs being intermediated through digital labour platforms[56]. The emergence of this trend can be traced back to the mid-1990s[57], when new work arrangements began to be introduced and regulated widely in Europe, both at national and EU levels. Key drivers in this respect were the Directives on part-time work (1997), fixed-term contracts (1998), and temporary agency contracts

(2008)[58]. From the 1990s until the start of the Great Recession in 2007-2008 in OECD26 (excluding the USA for which data is not available and including EU21) non-standard forms of employment accounted for about 50% of all job creation extending to 60% from the crisis year until 2013. On average 33% of total employment in OECD countries is in the form of NSW with wide-ranging differences among countries: as low as 20% in Eastern Europe to up to 46% in the Netherlands[59].

## 2.3 MARKETPLACE

The literature on the potential platformisation of the economy and its effects is scarce and we cannot rely on the well-developed hypotheses and models available for the effect on the workplace; hence, below we present a few considerations based on informed speculation.

**The rise of highly integrated digital platforms could lead to new oligopolies and monopolies:** One phenomenon forecast by experts is that the organisation of different parts of value chains through new technological capabilities will give rise to Cyber-Physical Systems (CPS). CPS would enable the geographical dispersion and fragmentation of production chains, facilitating mass customisation, just in time production, and optimisation of inventory. Industry documents and reports by consulting companies argue that this can only happen if some form of centralised governance is implemented. The virtualisation of supply chains and the abatement of silos is seen as achievable only if the integrated chain (seamlessly connecting suppliers, manufacturing, logistics, warehousing, and customers) is 'driven through a cloud-based command centre'[60]. Centralisation is not a certainty, however, and bottom up alternatives are possible; for instance, in user-controlled blockchain-guaranteed platforms. Yet, the issue remains as to what coordination mechanisms will emerge to steer fully digitised and integrated value chains, who will control such mechanisms, and whether or not they can lead to increasing oligopolistic and monopolistic market settings. It is, thus, from a policy and regulatory angle relevant to look at Industry 4.0 with respect to potential marketplace effects and possibly drawing lessons from the platform economy as it has developed so far. If we limit ourselves to what is in existence and has reached scale, we see in consumer platforms mostly centralised governance and at best oligopolistic (with only a few players) conditions.

Platforms represent a new structure for organising economic and social activities and appear as a hybrid between a market and a hierarchy[61]. They are match makers like traditional markets, but they are also company heavy in assets and often quoted in the stock exchange. Platforms, therefore, are not simply technological and economically focussed, they also have a social dimension that needs considering. Network effects from use of a platform may foster the rise of monopolies, or at least oligopolies, since it is advantageous to stick for example with one search engine, or one social network, or one online retailer resulting in an agglomeration of power in the hands of a small number of corporations. Similarly, in industrial markets network effects can accrue from the use of applications and services that comply with certain standards (whether formal or non-formal) that are facilitated by the platforms. Markets for platforms tends to be highly concentrated both for supply and demand side factors. On the supply side platforms have zero marginal cost and scale without mass, lower barriers to expansion, and with globalisation they can reach global dominance. On the demand side there are network effects (the value for each user increase with the number of other users).

**The Platform Economy raises new issues in relation to market regulation and competition.** From a legal perspective, integrated platforms are not simply corporations but a form of 'quasi-infrastructure'[62]. Indeed, in their coordination function, platforms are as much an institutional form as a means of innovation and should be regulated accordingly[63]. This focus on the platform dimension of Industry 4.0 clearly emerges in the two EC communications on digitising industry and on artificial intelligence[64].

Competition law identifies several important issues posed by digital platforms[65]. Firstly, the diffusion of mobile devices amplifies market power by providing a gateway to complementary applications. Secondly, controlling access to its own service, which affects the services and products of others may amount to bottleneck monopoly. Thirdly, and most importantly, customer data and information are critical and strategic assets and inputs to production. Platforms' own data and the data from other producers using the platforms can create considerable market power and competitive advantages.

**Market concentration within the Platform Economy presents new regulatory challenges.** Firstly, the classical argument is that dominant firms are eventually disrupted; yet, empirically in the last 5-10 years turn-over at the top within the digital space has all but decreased[66]. Secondly, it is claimed that the market leaders need to innovate to maintain their position and they thus ensure the best value for markets and consumers; but recently we have seen big platforms taking over potential competitors in pre-emption strategies. Thirdly, one positive effect of a dominant player is that it creates standards that are good for users and for integrating innovation; on the other hand, however, proprietary standards render users captive, reduce competition and diversity of innovation, while proprietary use of data creates a strong competitive edge.

## 2.4 OPPORTUNITIES

Industry 4.0 can deliver both tangible and intangible gains to the European economy and society, some of which are briefly summarised below, with just a few selective quantifications.

**Tangible economic gains relate to efficiency, productivity, increased revenues and investments.** Resource and time efficiency matched with productivity gains can increase industry revenues and boost global competitiveness. Real-time networking of industrial processes makes production cheaper, more sustainable, and efficient. Digital networking allows the direct involvement of customer demands and the cost-effective customization of products and services. Insights in customer behaviour could provide enormous potential for new products, services, and solutions that could enrich people's everyday lives. The promise is about efficiency in its purest form: maximum flexibility with the perfect flow of value creation. As Germany has been the first to launch Industry 4.0 initiatives, it is the country for which most quantitative estimates are available. Boston Consulting Group (BSC), estimated that Industry 4.0 will contribute about 1 percent per year to German GDP over ten years (additional revenue growth of about €30 billion per year), create as many as 350,000 net jobs (610,000 will be lost to automation, but 960,000 new jobs will be created), and add €250 billion to manufacturing investment (or 1 to 1.5 percent of manufacturers' revenues)[67]. Also, for Germany, Fraunhofer estimated productivity gains of around €78 billion in six sectors over a period of almost ten years: a yearly sectoral average of 1.7 per cent could be achieved as additional gross added value[68].

**Data-driven innovation will bring major economic benefits.** Another source of potential economic gains is the full deployment of big data and data analytics, as stressed by the European Policy Strategic Centre (EPSC), the EC Think Tank[69]. EPSC cites research according to which, even limited use of big data analytics solutions by the top 100 EU manufacturers could boost EU economic growth by an additional 1.9% by 2020. Citing empirical econometric estimations[70], EPSC also stresses that data-driven decision-making has been found to have a 5-6% higher output and productivity. Economic benefits would also spill over whether the needed investments to implement Industry 4.0 would be realised.

**Automation and AI could augment human work and have positive impacts on the workplace:** Besides these tangible economic gains, positive expectations exist also about a more human form of work, as well as about increases in high-skilled and well-paid jobs to which an increasing number of retrained individuals could have access. A recent report by Tata Communications[71], explores the idea of 'multiplicity' put forward by scholar Ken Goldberg[72]. In the multiplicity scenario groups of machines and humans collaborate to solve problems and innovate. Multiplicity is seen as offering a realistic and inclusive alternative to the Singularity Thesis, with systems of diverse combinations of humans and machines working together. The picture emerging is that AI has the potential to enhance collective intelligence and intellectual diversity, allowing human workers to do more diverse thinking, become more efficient, and undertake more creative, fulfilling labour.

## 2.5 RISKS

As the EP has noted, alongside potential benefits digital innovation also brings risks[73]. Negative externalities concern polarisation, the future of employment and social security, difficulties for SMEs, and the risk that Europe may have to accept standards and regulation being implemented by foreign jurisdictions (U.S., China, Japan, South Korea). These issues are further discussed below.

**Automation and digitisation risk polarising work and exacerbating labour market inequalities:** Firstly, there are the risks associated with increased polarisation and the future of work. On polarisation and inequality Guellec and Paunov have shown empirically how digital innovation is strongly associated (statistically) with increasing inequality: market rents extracted from digitalisation accrue to top managers, capital investors and employees of dominant firms, whereas income of average workers is stagnant and declining[74]. They further point out that digital innovation is made possible by the increase of fluidity and reduced frictions and barriers performed by digital platforms that, in turn, through network effects ultimately lead to winner-take-all market structures. This can be observed in the consolidation of the position of the so-called GAFA (Google Apple Facebook Amazon).

**Challenges to the taxation and social security systems:** Automation and digitisation alongside flexibilization are a source of uncertainty for how work in the future will be organised. Work is a way to maintain a dignified place in society and when large numbers of people are no longer able to find a job 'the functioning of the entire community may be impaired'[75]. If technological unemployment and intermittent employment become structural, then job polarisation and inequality may increase further[76]. At the same time expenditure for social protection may become unstainable due to lower tax and social security contributions from a smaller work force[77]. There is a danger that the combination of robotisation and platformisation may profoundly erode the tax base. The challenge will be dealing simultaneously with the tax base and unemployment and non-standard work (NSW), so that 'social policy can cover the needs of not just those outside the labour market but even many inside it' thus avoiding a crisis of the welfare state[78].

**Escalating shortages in digital skills across the economy:** Strong attention is given to the danger that the combination of robotisation and platformisation may profoundly erode the tax base. It must be also noted, however, that the economic literature on automation points out that, as tasks are re-specified as a result of automation and digitisation, new demand for certain type of skills will emerge and give rise to labour shortages at least in the short term. In some European countries, for instance, focus is more on labour shortages and in particular for jobs requiring digital skills. Hugh shortages emerge in innovative knowledge intensive sectors. But, partly caused by the retiring of the baby boom generation, labour shortages also occur in more traditional labour-intensive sectors such as education, health and other public service sectors. It is yet not clear to which extent this is a short term or rather more structural phenomenon.

**Ability to master digitisation will be key to firms' competitiveness:** Established industries in all sectors face competitive pressures as a result of digitisation and automation. Economic competition tends to be a zero-sum game, where benefits for some are losses for others. If Europe's traditional industries are unable or unwilling to leverage the current possibilities, and especially if they do not understand the implications of data-driven strategy, they will be unable to provide the customised and smart products and services future markets will demand. Across all sectors, SMEs will be most directly affected, either through lack of awareness or lack of the resources needed for the investments.

**Platformisation brings new challenges in terms of privacy and ethics:** There is a risk of monopolistic market effects produced by platformisation, as well as ethical and individual liberty issues. Data ownership and the protection of personal data and privacy still need to be addressed, given that applications and appliances will communicate with each other and with databases without humans intervening or possibly without them even being aware of what is going on. Due to their reliance on data-driven decision systems, CPS need ever more behavioural data and may require a complete overhaul of existing infrastructure. Luciano Floridi notes that in the practice of robotics the design of a robot's environment (called the envelop) is as important as the design of the robot itself[79]. So, CPS and/or integrated platforms may become new infrastructures that determine the architectures of choice for every aspect of our lives. The effects in the marketplace could spill over to the domain of societal impacts and individual liberties.

From the perspective of orthodox economic and managerial thinking, concerns about market structures in Industry 4.0 are just ways to call for unnecessary and distortive governmental interventions (i.e. industrial policy, new competition regulation, etc.). The argument is that innovation will overturn incumbents, as the constant disruption that characterises digital ecosystem giants comes and goes. If platform markets are oligopolistic, for a European firm it is irrelevant where the headquarters of a platform operator is located. The opposite view is that current technological developments in the context of informationalism and platformisation may threaten market competition and the very ethical and legal foundations of free market democracies[80]. It is, therefore, relevant to ask questions about whether Industry 4.0 platforms will reproduce oligopolistic or monopolistic tendencies, as well as which kind of platforms from which countries may end up in a dominant position. How pluralistically open or monopolistically closed will the market structure of Industry 4.0 become? Can incumbent integrated platforms from the US (or new platforms from China) get the upper hand and encroach European industry? This domain of change has geopolitical implications for global economic competition, as recognised also by American commentators[81].

# 3. FROM SCENARIOS TO SMART POLICY

## 3.1 POSSIBLE POLICY RESPONSES

Most European countries have an Industry 4.0 policy initiative in place[82]. These initiatives focus mostly on industrial and R&D policies and tend not to address the main strategic and more controversial issues presented previously, both in the Introduction and in Section 2. Hence, before moving toward scenarios, we consider first the most debated issues and related possible interventions with respect to the instruments selected for this paper: labour market broadly-defined regulation; and taxation. We will nevertheless keep the broader picture in mind and at the end of Section 3 point to other possible interventions concerning the risks of platformisation that cannot be addressed directly through either labour market or tax interventions.

### LABOUR MARKET AND SOCIAL PROTECTION

The future of work will be for sure about intermittent and insecure employment forms[83], but also about new skills and possible labour shortages in specific sectors. Within such context, labour market and social policies need to face opposing challenges and trade-offs and there are different possible approaches, of which we consider three: flexicurity with a social investment bent, unconditional basic income, and selective re-standardisation of labour contracts with tax reductions on labour.

A first possible approach is to focus both on unemployment and all forms of non-standard work (NSW). To do so effectively workers rather than jobs should be protected. One approach to this challenge is called 'flexicurity' (labour flexibility in the regulation of contracts plus social security)[84], ensuring eligibility to disability, pension, and other benefits are independent from the employment status of the person[85]. Flexicurity regimes, of course, can provide either more or less generous social protection[86]. We need to ensure that flexicurity is implemented in coherence with the emerging flexibility of labour contracts. This will need what we call (extended) Flexicurity 4.0. In this concept, social protection includes all domains of social benefits (incl. general education and health care), training and active labour market policies that promote labour market transitions and avoid crystallisation of two-tier labour markets. It would include labour contracts, though flexible, being reliable and incentivising formalisation (i.e. for those countries with sizeable informal economies) and transition toward open-ended contracts. Flexicurity 4.0 could be seen as being inspired by a social investment approach for all, facilitating flexibility in life transitions. It requires investment in human capital early on and throughout life, enabling adaptability to current and upcoming technological and social innovations[87]. Education, training and new skills are an important part of Flexicurity 4.0.

A second approach is to pay citizens an unconditional basic income that would guarantee access to basic necessary goods. This idea was first promoted twenty-five years ago by Philippe Van Parijs . Pilot projects are taking place in Scotland, Finland and elsewhere outside of Europe[89]. This idea finds opponents on both sides of the political spectrum. Some argue that it is too costly and would excessively reduce the supply of labour (this is a reasonable concern given labour shortages in selected sectors). Others say it might end up being a de facto neo-liberalist solution allowing firms to freely hire and fire (as costs are entirely borne by the public budget). A valid concern is that citizens are given money, but that it does not guarantee that they will have adequate access to healthcare, housing, and other entitlements that make up the social fabric of society as we know it. The latter issue could be solved by retaining publicly-provided education and healthcare and use of basic income only for unemployment benefits, basic pension rights, and child benefits. Recently, Soete after reviewing the current labour market developments related to technological innovation, has supported the introduction of a basic income to be financed through the introduction of a 'bit tax'[90].

A third approach, especially in relation to earlier cited labour shortages in certain sectors, is radically different from both Flexicurity 4.0 and unconditional basic income. This amount to a return to more fixed and guaranteed jobs and increasing the cost of firing labour. In this third approach labour market regulation and taxation overlap. One possibility is to incentivise firms to use standard contracts (or the gradual transition from non-standard to standard labour contracts) so as to reduce the tax wedge on labour. This would help achieve neutrality in the choice between workers and robots without introducing a capital or robot tax. A second possibility is selective R&D incentives linked to hiring experts rather than investing in technology. In the Netherlands, the R&D tax incentive provided to enterprises called WBSO/RDA[91] is directed towards the wage costs of scientists and engineers. The same principle applies to the extensive fiscal R&D support facility offered in Belgium.

### FORMS OF TAXATION

Tax changes can come in various ways, from across the board to selective and delimited incentives. And there are various different taxes, e.g. on income, capital, value added, property, consumption, etc. An even basic review of these possibilities is beyond our scope and space, and we focus only on the two possibilities that have been most debated recently: 'the robot tax' and a 'digital intermediary tax' (see also § 5.4 of Annex II).

Recently, 'robot tax' entered the political debate as a result of a proposal presented to the EP by MEP Mady Delvaux[92]. The proposal underscored the 'need to introduce corporate reporting requirements on the extent and proportion of the contribution of robotics and AI to the economic results of a company for the purpose of taxation and social security contributions'. The public reaction to this proposal has been overwhelmingly negative for practical as well as ideological reasons, with the notable exception of Bill Gates, who endorsed it[93]. Eventually in early 2017, the EP voted it down citing concerns over stifling innovation[94]. But increasing attention is now being given to the tax side of AI[95]. In June 2017 South Korea announced limits on tax incentives for businesses investing in automation. In its recently announced tax law revision plan, the Moon Jae-in administration said it will downsize the tax deduction benefits that previous governments provided to enterprises[96]. In OECD countries there are substantial tax incentives (i.e., credits) in support of R&D and innovation and/or of technological infrastructure[97]. They include, among others, R&D tax credits, allowances, payroll withholding tax, social security contributions or accelerated depreciation of R&D capital. Some incentives are directed to the labour side rather than to equipment and infrastructure, although these are less widespread. If measures would restore tax neutrality between machines and people, it might improve efficiency by allowing firms to decide on use of workers or machines without tax-based bias. If tax policies encourage innovation through automation, this gives firms an incentive to replace workers with robots, even when workers might otherwise be better[98].

Other forms of tax can be based on a levy on: (i) online advertising, (ii) seller/buyer fees transacted via online intermediaries and marketplaces and (iii) the sale of user data. We will call such a tax a Digital Intermediary Tax (DIT). It would be due by firms with significant digital presence in a Member State based on revenue, numbers of users and contracts. The EC proposed in March 2018 two directives aimed at a similar tax[99]. These proposals have been rejected by the Council in December 2018.

Essentially, a DIT introduces a destination base taxation that would: a) shift tax revenues to the EU with its large user market from other countries with a high concentration of digital intermediaries; b) reduce the scope for tax competition within the EU. Unlike a robot or capital tax, a DIT does not affect the physical capital side of the transformation process, but the digital intermediaries owning the digital platforms. In this respect, it is neutral to innovation investments in AI, automation, and digitisation inside manufacturing.

A DIT would bear some resemblance to the 'bit tax' proposed more than twenty years ago by Soete and Kamp[100]. The bit tax idea was simple: levy an excise duty on the use of digital infrastructure just as is done for the fuel of motor vehicles using our roads. The argument that this would be already covered by VAT is flawed since revenues from advertising accrue to large platforms mainly from digital services provided for free. The bit tax focused on all uses of digital communication, whereas the DIT can be read as implicitly targeting the large global social media firms and platformisation.

## 3.2 SCENARIOS: CORPORATE TAXATION AND LABOUR MARKET REGIME

The scenarios presented in Figure 2 aim at helping define a course of action to boost Industry 4.0 in Europe in a way that combines growth and cohesion. Making scenarios extreme, also through several simplifications[101], enables to capture collectively (by all four scenarios) most of the possible features that will characterise the future, including those aspects policy makers may want to avoid. The scenarios rest on two underlying assumptions that characterise all of them: a) labour market flexibility as a structural pattern that is to stay (with exceptions for sectors facing labour shortages where some re-standardisation of the labour contract can be incentivised); b) the extensive existing regime of R&D tax incentives for investments in technology are maintained. Moreover, because taxation and labour market regulation are not orthogonal (e.g. tax on labour), we treat the taxation dimension as pertaining only to corporate taxes and we consider changes in the taxation of labour as part of the labour market regime dimension.

The labour market regime has two extremes: 1) Labour-friendly with Flexicurity 4.0 based on extensive social protection and social investments (i.e. a strong emphasis on skills and training) and is matched by tax measures that can introduce neutrality in the choice between workers and robots (cut of tax wedge and introduction of human side R&D tax incentives). Labour is considered as an active factor of digital transformation. 2) Labour-neutral with full labour market flexibility without extension of social protection. Labour is treated residually and entirely as a commodity.

Along the dimension of corporate taxes, higher taxes concern only introduction of a DIT but not of a capital (robot) tax, while R&D tax incentive for investments in machinery are retained. Lower taxes include retaining R&D tax incentive for investments in machinery, but also a cut in corporate taxes.

The **Utopian** scenario will lead to a dire financial crisis of public finances as it would at the same time lower taxes and increase spending. It would, most likely be perceived as fair and be welcomed by a large spectrum of social groups and stakeholders. This is a source of political risk in that it could achieve wide support and then fail to deliver leading to political instability.

In the **Dystopian** scenario higher taxes would not be used to increase social protection. It would strengthen the support to technological innovation for machinery-related R&D without any investment in human capital. The tax incentive would lead firms to substitute more

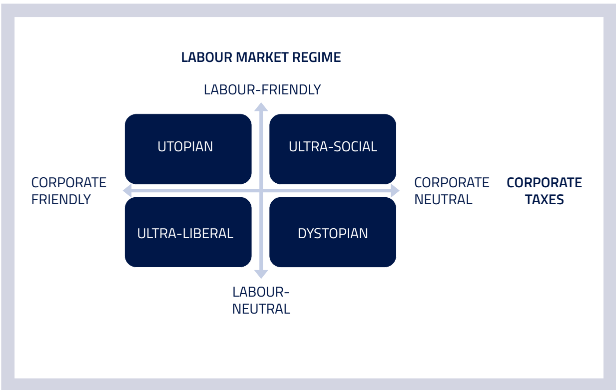



FIGURE 2: Proposed scenarios

workers by machines without extension of social protection. NSW will increase with lower wages and without improved access to welfare benefits, leading to exclusion of a large group of workers. Without any real attempt to seize opportunity and manage risks, political instability would increase.

The Utopian and Dystopian scenarios are discarded here outright. Both represent extremes that we do not wish to slide into, unknowingly dragged by the forces of digitalisation.

The two remaining scenarios have opposite ways to support the digitalisation of industry. These opposites we call: Ultra Social and Ultra-liberal. The former aims at turning technological into social innovation by fully transforming the mix between technology, economic incentives and the social fabric, whereas the latter aims at a fully liberal approach on technological innovation and economic incentives. Below we give more detail.

**Ultra-social**

A DIT is introduced while retaining R&D machine-related tax incentives, at the same time as a new labour market regime is defined including Flexicurity 4.0 together with social investments and a cut of tax wages. In addition, human-side R&D tax incentives and incentives for re-standardisation of the labour contract could be applied to selected sectors (i.e., those facing shortages) and gradually. A DIT has no effect on the productivity of manufacturing firms and limited effects on digital platforms and company, as it is compensated by R&D tax incentives for machinery. Considering also the incentives to attract qualified workers and the social investment in human capital, one can expect a positive effect on productivity and economic growth.

Increased tax revenues from a DIT and growth are used to finance Flexicurity 4.0, the cut of the tax wedge, and incentives for human-side R&D. Reduced labour supply (effect of more jobs in industry and flexicurity) will reduce the share of NSW and increase wages, so increasing inclusion and reducing polarisation. Under this scenario, there would be three level playing field effects: a) on platformisation by way of a DIT; b) increased neutrality in the man-machine race through the labour-oriented tax measures; c) less of a two-tier and more inclusive labour market through Flexicurity 4.0. The perceived fairness of the system by a majority of the citizenry will increase and no strong political risks and opposition are expected. The budgetary sustainability is moderate and will depend on the size of tax revenues from a DIT, the extent of productivity and growth, and on the actual costs of Flexicurity 4.0.

Nevertheless, this scenario entails instability risks at the geopolitical level, globally and within Europe. Globally, strong opposition and lobbying by giant intermediary platforms may cause retaliation by key geopolitical competitors. The risk of tax competition from geopolitical competitors and capital outflow exists but is much lower than in the case of introducing a capital tax. It also requires strong coordination at European level to avoid tax competition between Members States and labour migration for social protection

**Ultra-liberal**

This scenario entails cuts in corporate taxes and retaining or even enlarging machine-related R&D tax incentives. No new taxes are introduced, and social spending will not increase given the labour market regime. There will be no major social reform comparable to the Flexicurity 4.0. The combination of lower corporate taxes and R&D tax incentives for machinery would spur innovation and efficiency boosting productivity. Productivity can be expected to increase more than in the Ultra-social scenario. Capital becomes relatively less expensive and profits after taxes will increase. Hence, manufacturing firms would heavily invest in technology and substitute workers with machines. Employment in industry would decrease and the supply of labour outside industry will increase. This will produce a larger share of NSW and also at least some level of technological unemployment, while wages will decrease.

Firms' choices between man and machine will be further biased in favour of the latter through taxation. Polarisation and social exclusion will increase not only in terms of wage differentials but also because of larger corporate profits. Low social protection for NSW will

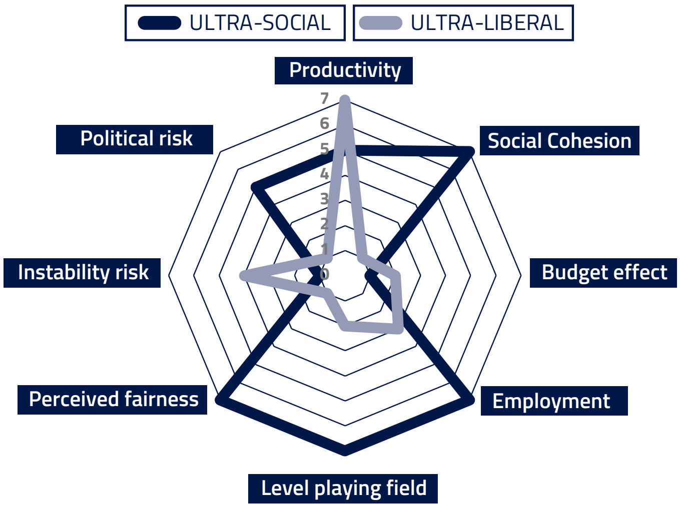



FIGURE 3: Comparing the Ultra-social and Ultra-liberal Scenarios

further undermine social cohesion. This scenario will be perceived as unfair by a majority of the citizenry, which weakens social cohesion and creates political risks. Without a DIT and under no changes in competition and consumer protection policies, there is no global level playing field on platformisation and a high risk that the market power of existing giant digital platforms increases and expands into Industry 4.0.

Risks in the relations with geopolitical competitors should not arise; actually, capital inflow from outside Europe may take place given lower corporate taxes. The budget sustainability seems higher compared to the Transformation scenario. There are less revenues from tax cuts and R&D tax incentives, but little additional social spending and more revenues can be expected from economic growth and capital inflows.

## 3.3 CONCLUSIONS

The two contending scenarios highlight trade-offs as shown in Figure 3. The two scenarios that are presented in a narrative fashion in the previous section are here rendered into a quantitative scale based on the same economic logic (with the disclaimers given in section 4.5 of the Technical Annex). Impacts go from very negative (1) to very positive (7). Quantitative scores are used for presentation purposes, drawn from the qualitative assessments and given in comparative and relative terms. For example, the maximum score 7 on productivity (through innovation and efficiency) in the Ultra-liberal scenario should be interpreted relative to the 5 in the Ultra-social scenario. The lower taxes and R&D incentives for machinery are expected to push productivity more than the measures foreseen in the Ultra-social scenario. In the same way, with opposite effects, social cohesion is considered to be much stronger in the Ultra-social scenario as argued in the previous section.

When making use of labour market interventions and corporate taxation there are just two realistic options:

- **the liberal market-driven approach;**
- **the approach giving strong attention to social aspects.**

The former maximises productivity effects but may increase polarisation and lead to political instability and has no level playing field effect. The latter has a better outcome in terms of social cohesion

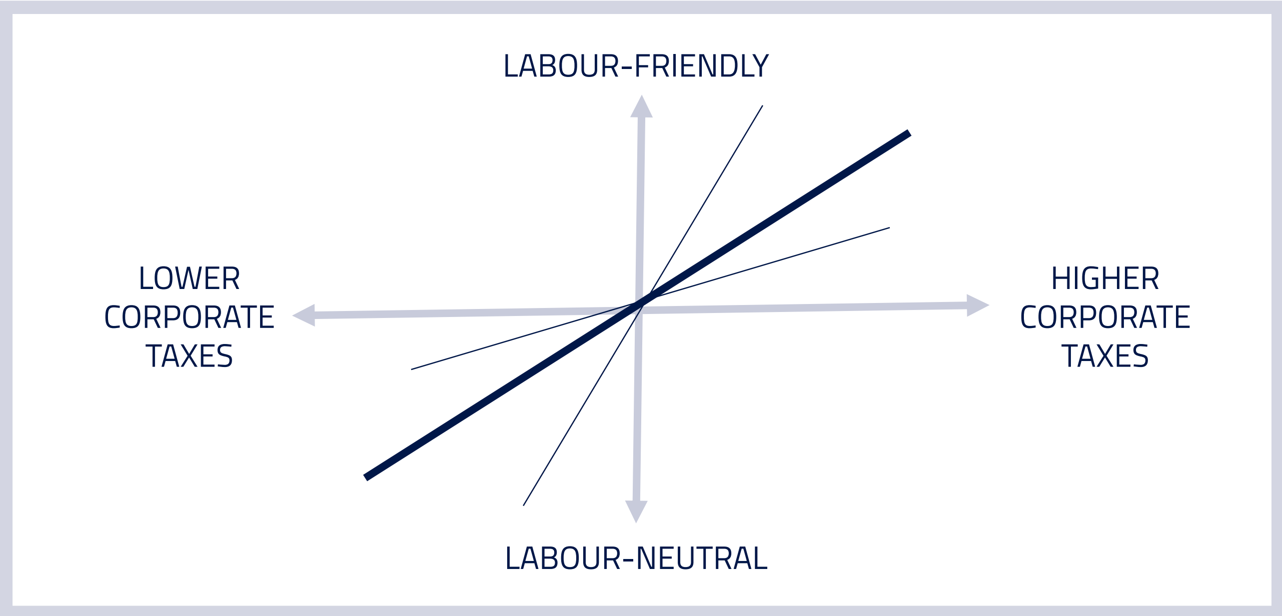



FIGURE 4 The diagonal of policy choices

through fairness (both factual and perceived) and level playing field effects but entails some instability risks, especially in terms of geopolitical relations and competition.

However, the distinction between the two scenarios above should not be seen in black and white. We can look at them as being at the two extremes within a continuum of possible approaches along the diagonal that goes from one corner to the other. Dependent on the political consensus achieved, a balanced combination of elements from both scenarios can be constructed, creating a labour-friendly environment with technical and social innovation, leading to economic growth and social cohesion.

This can be further illustrated by disentangling the measures from the scenarios and integrating tax and labour market interventions with interventions in the domain of competition policy and data policy, as is the case in the following radar diagrams. Fiscal policies are legitimate instruments to address inequalities and pursue level playing field effects. One should be careful to avoid deterring innovation while trying to increase competition[102]. The risk caused by less competition in the market for platforms and data can be also addressed through different policies[103].

Access to, and ownership of data directly shape market structures and distribution of revenues and profits in digital transformation. The current large incumbent platforms exclusively own the personal data they collect, which is a source of competitive advantage and rent. This can be countered by regulations allocating rights on users' data in a more equitable way, thus fostering greater competition and innovation. In the same way, new approaches to competition policy and regulation are needed, aimed at defining market power that is more attuned to the digitised world and less to the past industrial economy. German and French authorities in Europe have recently done some work on platforms[104]. Learning from experiences with platforms for connected and automated driving (which can be seen as a somewhat more mature inspiration for industry 4.0 platforms), the EC indicated that 'centralisation of data might in itself not be sufficient to ensure fair and undistorted competition between service providers'[105]. So, data and competition policy to level the playing field and ensure competition in the future of emerging Industry 4.0 platforms should complement tax and labour instruments.

Similar to the diagrams in Figure 3, in Figure 5 the diagrams point out limits and trade-offs of specific individual measures in that each maximises only certain aspects and is insufficient to strike the best balance between seizing opportunities and managing risks, or between our two chosen scenarios: the Ultra-liberal giving growth-enhancing innovation and the Ultra-social giving social cohesion enhancing fairness. Nevertheless, Figure 5 suggests that a good and balanced policy mix can be achieved by fine tuning and mixing the various measures.

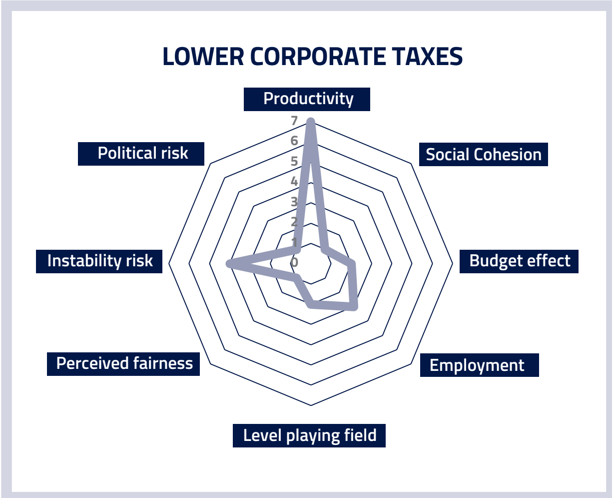
The diagrams in Figure 5 can be used to to develop and strengthen the political consensus on the balance between the two scenarios above, for example by a strong industrial policy of investments, to stimulate European platform development and take up, and new data sharing and competition regulation.

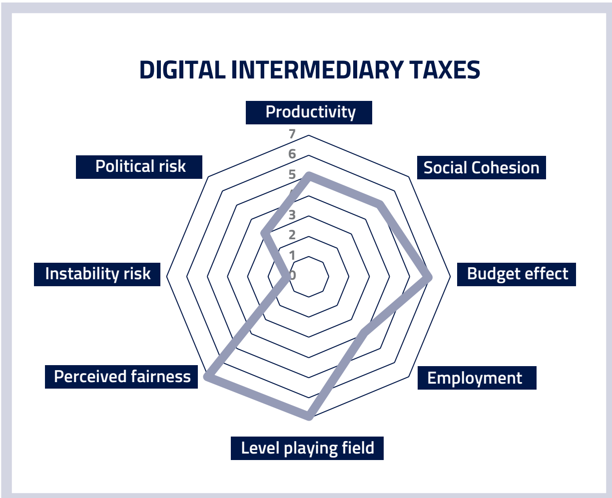
Political cohesion internal in the EU is essential to achieve the right balance for Industry 4.0 to produce economic growth, social cohesion and European solutions. InvestEU, Horizon Europe, Digital Europe, and the related deployment, capabilities and cohesion programmes in discussion, can support this process.

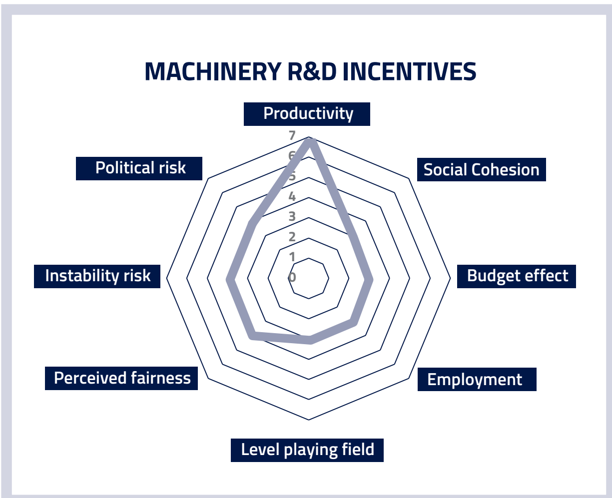
It could be considered to pursue a coalition of labour market decision-makers and innovation/technology policy-makers in Europe to find such balance. EU unity is also required to manage the global forces in capital and technology, for example through the OECD.

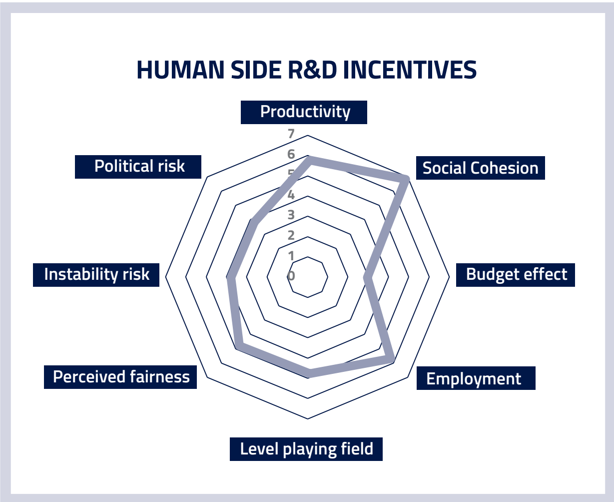
If Europe would be pushed to the extreme point of the Ultra-liberal scenario, it is likely that European Industry 4.0 platforms will be marginalised.

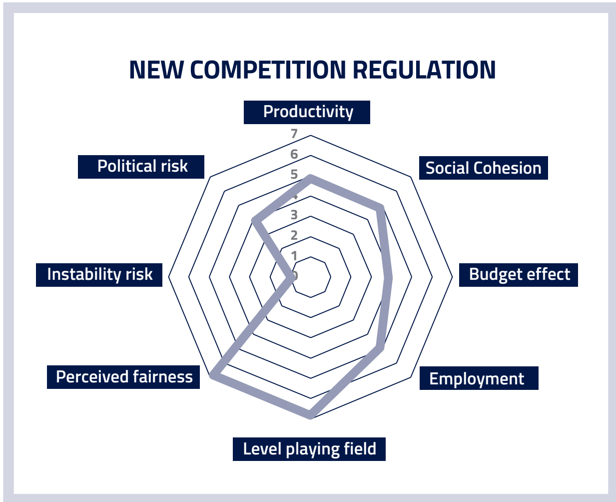
A balanced transformation can be funded by higher growth, a common higher but selective approach to taxation and if needed, temporary budget deficits.

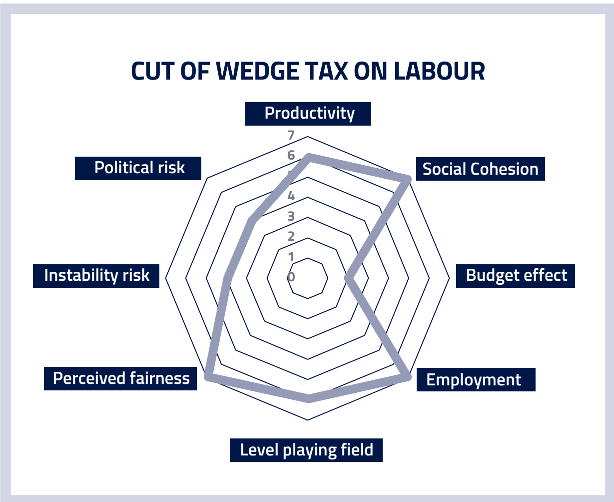


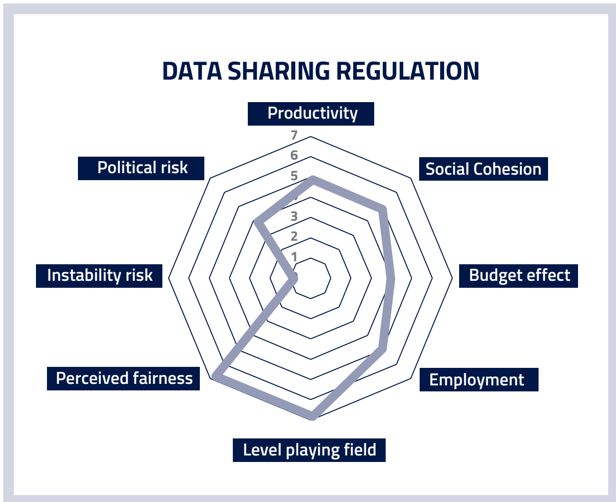





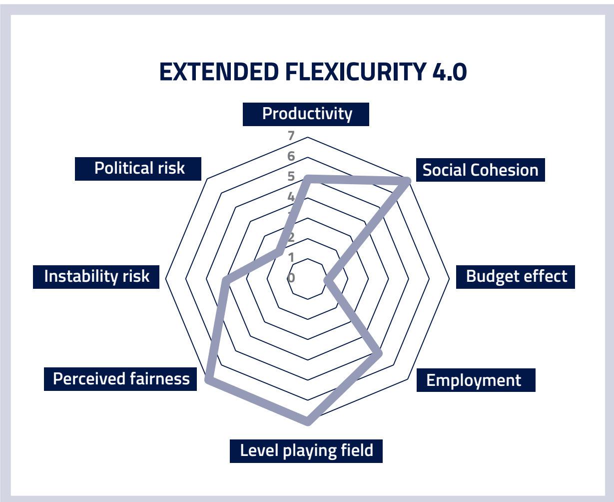




FIGURE 5 Assessment of Various Policy Measures

# 4. TECHNICAL ANNEX

## 4.1 ON THE CONCEPT OF TWO- AND MULTI-SIDED PLATFORMS

Since 2002, a growing body of economic literature has analysed situations that broadly qualify as two-sided or multi-sided markets[106]. These range from analogue situations as in dating clubs to what are today called digital platforms of various types. Two-sided or multi-sided markets or platforms are situations where one operator (called market or platform) enables two or more groups of users to interact (and in many cases transact) in ways that at least one group and usually all groups benefit directly or indirectly from having a growing number of users on the other side(s). These are the so called direct and indirect network effects. Initially, the main focus of this literature was on payment systems, auctions, operating systems, and media markets. Lately, however, it has been increasingly applied to digital platforms, some of which are the object of controversy over whether or not they can be considered two-sided[107]. This has implications for competition policy and, in fact, also the most popular platforms of the sharing economy have been considered as a possible source of concern for competition policy[108].

The economic theory explains how and why value is created by both users and providers and is accumulated by the platform owner. It explains how value generation and profit making rely on crossed network externalities: value on one side of the market depends on positive network externalities on the other side. In some cases, gratuity is the optimal price setting on one side of the market (for example, Facebook). It also explains the specific nature of unpaid digital labour, that is, users providing 'labour', in the case of Facebook in the form of content creation, without receiving a monetary remuneration. As summarised by Codagnone & Martens[109], platforms internalise these network externalities, by facilitating the matching between sides and reducing transaction costs. Matching can be search-based with fixed prices and still involve considerable search costs for consumers; or it can be a variable price auction mechanism (entailing lower search costs) or a variety of in-between mechanisms. The economics provide important insights into the functioning of digital platforms and into the policy concerns that they raise. Digital platforms can generate strong network effects: the value of a platform and the number of transactions increases more than proportionally with the number of participants. The higher the number of participants already on the platform, the more others will want to join because it increases consumer choice and boosts markets for service suppliers.

The first to look at firms serving two different types of customers and facing the 'chicken and egg problem' were Gawer & Cusumano in 2002[110] and Caillaud & Julien in 2003[111]. These authors referred to 'intermediary markets' serving two distinct groups of customers. The expression 'two-sided market' was first introduced by Rochet & Tirole[112]. In parallel, Evans used the expression 'two-sided platforms'[113] and was one of the first to systematically apply this perspective to the digital economy[114]. On the other hand, Parker & Van Alstyne were converging on 'two-sidedness' coming from network and information theory[115]. Rysman[116] also used the expression 'two-sided strategies' to convey the idea that there are choices made by agents rather than an imposed endogenous industry structure. Hagiu & Wright also looked at multi-sided platforms as a matter of firms' strategic choices[117]. Building on the theory of the firm, they framed these choices as a trade-off between being a Multi-Sided Platforms (MSP) or a vertical integrated firm, or between controlling versus enabling.

There are different approaches to identify the conditions of two-sidedness, which can be ascertained only empirically considering specific cases. Following the analysis presented by Li (2015), three approaches can be identified with regard to how two or more groups of users interact: (1) two groups of customers exert bilateral indirect network externalities; (2) only one group of customer exerts unilateral indirect network externalities on the other; and (3) the existence of indirect network externalities is not necessary. In the first approach indirect network effects on both sides are fundamental and the role of the platform (intermediary) is to internalise the externalities produced by the fact that the decision of each set of agents affects the outcomes of the other set of agents. In the second approach the definition has been relaxed and it is considered sufficient that network effects exist for at least one group of customers. In the third approach, proposed by Rochet & Tirole in 2006: 'A market is two-sided (a two sided platform exists) if the platform can affect the volume of transactions by charging more to one side of the market and reducing the price paid by the other side by an equal amount; in other words, the price structure matters, and platforms must design it so as to bring both sides on board'[118].

Whether or not a particular activity qualifies as a two-sided market has relevant implications with respect, for instance, to competition policy[119]. Many traditional axioms of economic analysis that inspire competition policy do not hold and should not be used when markets are two-sided. For instance, pricing to one side below marginal cost is not a predatory behaviour but rather a common profit maximising strategy in two-sided markets. Defining the relevant market for antitrust purposes and looking at only one side can lead to a market definition that is too narrow. Furthermore, network effects can lead to tip toward a single dominant platform[120]. The two-sided perspective has been used by the European Commission (EC) and the EU courts, i.e. the General Court (GC) and the European Court of Justice (ECJ), when applying EU competition law[121]. Hence, the question of which markets are two-sided has become increasingly relevant[122], although it remains an empirical matter to be ascertained case by case[123].

It is clear that digital platforms generating network effects can give rise to monopolies, or at least oligopolies, since it is advantageous to stick, for example with one search engine, or one social network, or one online retailer resulting in an agglomeration of power in the hands of a small number of corporations. Platform operators act as both infrastructure provider and intermediary between supply and demand. Commercial platforms are online spaces which instead of the traditional supply and demand side also include the platform provider itself. Software, which constitutes the virtual architecture for these online spaces, runs in rented data centres (that is the 'cloud'). The two opposing groups of users for supply and demand see different and very limited front-ends of the platform, that is small parts of the data and the processes of the system. The providers of the platforms, however, can access the back-end that gives them a complete big-data overview of all the interactions between the two user groups. Moreover, platform providers entirely monitor and can influence the interactions and transactions between the different sides. Through algorithms they can filter who sees what, given certain conditions, what features are available and what actions are possible. It is a control implemented technically, through the terms of condition, and also through the graphic interface. This is a further aspect causing a systemic power asymmetry but also information asymmetry in favour of the platform providers (see also section 'Information asymmetry and data protection'). The three-sided structure of the intermediating platform is also important for the providers, since it enables a way to shift entrepreneurial risks, legal liabilities, the cost of labour and the means of production to the other two parties. Furthermore, the intermediating platform is a non-material software product able to potentially scale exponentially, but the providers do not have to spend proportionally more on staff or other costs of production.

There are, however, different conditions that may favour or hamper scale to dominance by platforms. Under clear network externalities the presence of indirect network effects promotes larger and fewer competing platforms. Only at some points and under specific circumstances, positive externalities from more participants may turn into negative externalities in the form of congestion. In many cases there is a fixed cost of providing a platform (i.e. investments over the years to solve the chicken and egg challenge and bring two sides on board), which means that economies of scale favour large platforms and concentration. In physical match-making platforms (i.e. dating club) there are evident physical limits to growth beyond which the problem of congestion arises. Congestion increases search and transaction costs and it also affects digital platforms. Unless solved otherwise (increasing size of dating club or improving search and matching algorithm in digital platforms), congestion limits growth and concentration. Vertical integration (i.e. upscale and downscale online market places) or horizontal integration (i.e., between Airbnb and Homeaway) reduces size and concentration and favours multi-homing whereby on one or on both sides of the market users choose to join and use several platforms. Heterogeneity of users and/or the object of exchange make matching more difficult and reduce the potential for scalability and concentration. So, digital platforms can generate strong network effects, reach scale and trigger competition policy questions, although as seen scaling up to dominance (size) and industry concentration are constrained by congestion, heterogeneity, and multi-homing.

## 4.2 MAIN HYPOTHESES ON THE EFFECT OF AUTOMATION

According to the Skill Biased Technological Change (SBTC) hypothesis, computerisation will substitute low skills jobs, meaning that the risk of jobs being automated will mainly regard low-skilled and low-income individuals. This hypothesis has not found strong empirical corroboration and has left space to the alternative Routine Biased Technological Change (RBTC) hypothesis. According to this hypothesis, the amount of routine involved by a job will determine the possibility that it is automated and substituted by machines (being computer or robot).

One of the main proponents of the RBTC hypothesis, David Autor, has recently presented a more realistic approach to the problem of automation, asking the question why there are still so many jobs[124]. According to Autor, one of the effects of automation on labour market is also that of increasing the value of the tasks that workers uniquely supply. So, there is both substitution and complementarity between labour and machines and the current polarisation of the labour market may not continue in the future.

Along the same line of reasoning, the model proposed by Acemoglu & Restrepo envisages both substitution and complementarity[125]. According to these authors, technological innovation can either directly displace workers from tasks that are fully automated (displacement effect) or indirectly increase labour demand by industry or jobs arising as a result of technological progress (productivity effect). Only if the long-run rental rate of capital relative to wages is sufficiently low, then the equilibrium involves automation of all tasks. Otherwise, the two types of innovations will go hand-in-hand. Yet, they also recognise that in the transitional period polarisation and inequality may increase, driven by faster automation and introduction of new tasks.

## 4.3 OVERVIEW OF ESTIMATES OF THE EFFECTS OF AUTOMATION

Moving from hypotheses and models to econometric estimations and forecasts, the evidence is not conclusive or consensual. Frey and Osborne, in a much debated and criticized paper[126], using an occupation-based approach estimated that 47% of total US employment is at risk because of computerisation and robotization. A replication of this methodology for Europe put the share of workers that may be displaced by technological change between 40% and 60% depending on the country[127]. On the other hand, using a task-based approach, a paper by the OECD estimates that in its member countries the loss of job would reach maximum on average 9% of employment[128]. One possible reason for the high estimates of potential job loss by Frey and Osborne is that their analysis is based on asking experts the 'automatibility' of 70 occupations. But, as argued in the OECD paper, experts tend to overestimate the potential of new technologies. Technological capabilities do not always and automatically turn into possibilities. Technologies must be embedded into socio-economic settings, which may delay and/or limit full deployment. The extent to which human wisdom and pattern recognition can be really dispensed of and embedded into machines is still debated and often overstated. Finally, there are many ethical and legal obstacles and, as put it provocatively in the cited OECD paper, how an algorithm running a driver-less car should decide between crashing into a car or a truck?

According to Bessen, it is too simplistic thinking that just because computers can perform some tasks jobs will be eliminated[129]. As an example of the opposite, he shows that during the 90s automated teller machines (ATMs) diffused enormously, reaching more than 400,000 installed in the USA. Following the Frey and Osborne argument one should expect a strong reduction in the number of employees working as bank tellers, instead these have been constantly growing after 2000. In Bessen's analysis, this happened because banks increased the number of branches and because those tasks that could not be automated became more valuable: as banks pushed to increase their market shares, tellers became an important part of the 'relationship banking team'. Many bank customers' needs cannot be handled by machines, particularly small business customers. Tellers who form a personal relationship with these customers can help sell them on high-margin financial services and products. The skills of the teller changed: cash handling became less important and human interaction more important. In another contribution Bessen shows that estimates reject computer automation as a source of significant overall job losses, but he acknowledges that computerized occupations substitute for other occupations, shifting employment and requiring new skills. Because new skills are costly to learn, computer use is associated with substantially greater effect within the occupation wage inequality[130]. In a more recent analysis Bessen analysed US cotton textile, steel, and automotive manufacturing industries to explore the share of technology in job growth and decline. He concluded that most job losses can be attributed to trade, the recession, and changing consumer preferences and not much to technology[131].

Acemoglu & Restrepo, in another contribution using the data in the post-1990 era, found that one additional robot per thousand workers reduced the US employment-to-population ratio by 0.37 percent and wages by 0.25-0.5 percent on average[132]. Graetz and Michaels[133], using data on a panel of industries in 17 countries from 1993-2007, found that industrial robots increased labour productivity, total factor productivity, value added and wages. In relation to employment, robots had no significant effect on total hours worked, but according to the authors there is some evidence that they reduced the hours of both low-skilled and middle-skilled workers. Goos et al, show a decrease in the demand of mid-paid jobs in comparison to high and low paid occupations, that can be explained both by the RBTC and by task offshoring[134]. Dauth et al (2017)[135] using data for Germany did not find significant negative impact of robots on employment. While industrial robots have a negative impact on employment in the German manufacturing sector, there is a positive and significant spill-over effect as employment in the non-manufacturing sectors increases and, overall, counterbalances the negative effect. Chiacchio et al estimates the impact of industrial robots' penetration on local labour markets and find the negative impact of robots on employment rate to be modest, while they do not find robust significant impact on wages[136].

## 4.4 SELECTIVE OVERVIEW OF THE DEBATES ON TAXES

Goldin suggests financing social security by raising top marginal income tax rates, increasing capital income tax rates, introducing wealth taxes and reducing tax avoidance[137]. Duchatelet points out the need to offset the loss in funding by other means than taxing (low wage) labour[138]. He suggests reducing the costs of social security administration through efficiency gains and using the profits of state-owned companies to fund social security. He argues that the redistributive logic behind social security funding needs to be reconsidered and advocates higher taxes on areas such as energy consumption as well as in gambling, alcohol and tobacco. He is also in favour of a tax on products made by robots (by increasing the VAT and/or the sales tax).
A common objection against the robot tax is that it puts an additional burden on investments in a context of economic slowdown and a lack of investment, notably

due to austerity policies. A tax that would increase the costs of robots in a context of cheap human labour would delay increases in productivity. For example, Zhang (2017) points out that tax authorities would need to make 'the perhaps impossible distinction between labour-saving machines and labour-enhancing ones' and to change the approach to taxing business investment in equipment[139].

Summers opposes the tax on the grounds that robots not only increase output but also produce better goods and services and therefore further taxation would stifle innovation[140]. He argues for better redistribution of wealth rather than hindering growth or drive production offshore. His preference for addressing structural joblessness through the public sector and the 'need to take a more explicit role in ensuring full employment' links with proposals advocating for the government being an employer of last resort through a job guarantee. Meyer proposes job guarantee schemes with requalification/retraining as a key component that could be used to strengthen the health and social care sectors[141]. According to Schiller, a moderate tax on robots that: 'slows the adoption of disruptive technology, seems a natural component of a policy to address rising inequality. Revenue could be targeted toward wage insurance, to help people replaced by new technology make the transition to a different career. This would accord with our natural sense of justice, and thus be likely to endure'[142].

Other alternative taxation schemes in the digital economy have been suggested, such as the 'bit tax' proposed by Soete and Kamp[143]. It was inspired by the 'Tobin tax' on financial flows and followed the same principle: a very small percentage of taxation on network exchanges of digital data, aimed at feeding social security systems under threat. The proposal was not taken up due to the criticism of the IT industry.

## 4.5 ECONOMIC EFFECTS: BASIC ECONOMIC REASONING

In order to assess the economic effects of taxation, labour market interventions, and of other measures considered in the conclusions, we used simplified economic theoretical reasoning, focussing mostly on manufacturing firms' (i.e. the players of Industry 4.0) decisions about tasks specification and assignment between labour and machine. Then, we residually considered other effects of such decisions on the labour markets outside of manufacturing, applying a general equilibrium logic , such as how the demand and supply of labour change both in relation to manufacturing firms' decisions, and other general effects such as whether or not government make investment and stimulate the demand for labour. We looked at the dynamic interaction between labour demand and labour supply in order to scope effects on whether the share of Non Standard Work (NSW) increases or decreases, as well as on wages in general and on the wage differentials between workers in standard employment and workers under NSW forms (including so called 'gig workers'). We also had to speculate on elasticity of final demand for digital platform services (both consumers of final services and third-party firms selling their products on the platforms) in relation to the possible direct and indirect effect of a DIT. Before proceeding, however, a strong disclaimer is in order on the speculative nature of this exercise. The general theoretical reasoning, in fact, is sound but not conclusive given total uncertainty about the empirical dimension of key parameters (i.e., especially elasticities). Therefore, we had to make some assumptions in order to provide an assessment of the impacts of the various scenarios and related measures. Especially, assessing ex-ante the effects of a new tax is a fairly hazardous undertaking. In the context of the current debate in the US about the 'Tax Cuts and Jobs Act' legislation, for instance, policy makers and economists are engaging in a mostly speculative exercise about its effects[144]. They attempt parsing limited and incomplete data, while such effects will realise and can be evaluated only over the course of several years. There is always a difference between the statutory and economic effects of any piece of legislation, and this is particularly so for taxation. Whereas statutorily the target of a tax may be player A, the actual effects may be shifted by player A onto player B. A tax on firms may be transferred, for instance, to consumers. Yet, both in this specific case and in other situations, it will all depend on the elasticity of supply and demand to the direct effect of the tax and to its indirect effect (i.e. the attempt by the hit player to pass on the costs on some other players). If consumers' demand is rigid (low price elasticity) the cost of the tax can be shifted to them; conversely if it is elastic a raise of price to pass on the cost of tax would lead consumers to choose an alternative consumption and it will be more difficult for the player hit by the tax to shift its costs. This is one of the most basic economic principle about the interaction of supply and demand and its effects on prices in all markets (for goods and services, for labour, for capital). Whereas elasticities can be estimated from past data on similar interventions, any new tax may have its own peculiar and difficult to predict effects.

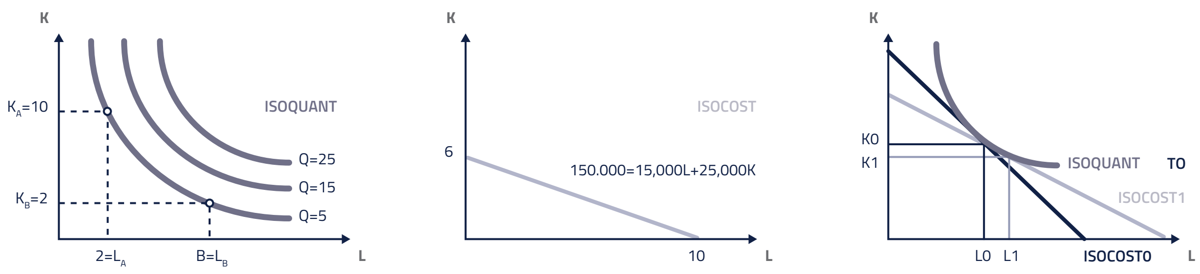
Not surprisingly the ex-ante assessments of the effects of the DST proposed by the EC are starkly contrasting when comparing that produced by the economists of the European Commission[145] for the Impact Assessment (IA) with that of European Centre for International Political Economy (ECIPE)[146] and, especially, with that contained in a study recently released by Copenhagen Economics and (it should be underlined) commissioned by the Computer & Communications Industry Association[147].
In this report we discuss a similar tax, here called Digital Intermediary Tax (DIT) with comparable effects. For instance, the extent to which the cost of DIT on platforms may be shifted on final consumers will depend on the elasticity of demand to price. According to the Commission the elasticity of online consumers to price is high and, so, this shift is unlikely; critics affirm the opposite. The same applies for the indirect effects of the DIT on the third-party producers (especially SMEs) that use large platforms to sell their products and services. The critics of the DIT argue that third-party producers will have to pay larger transaction fees to the platforms; the counterargument is that they can switch to competing and emerging platforms applying lower fees.

In general, the effects of the DIT depend on three elasticities: a) the elasticity of the final demand to price; b) the elasticity of labour supply; c) the elasticity of capital supply. If the elasticity of final demand to price is high, then the full cost of DIT will fall on the producers (platforms and third-party producers). The producers would adjust their use of factors, namely capital and labour, reducing both. Yet, ex-ante, it is impossible to say whether the reduction will be greater in terms of capital or labour. It depends on the elasticity of each factor. If a factor is relatively more rigid (to its price), it will receive a lower remuneration, but quantity used will not change. Conversely, if it is elastic the opposite would occur. Furthermore, much depends on whether the producers hit are only the big platforms and pure digital companies or also the third-party producers using digital platforms to sell their products and services. If only digital platforms and companies are hit, since they use little labour the impact on employment would be marginal.

On the other hand, since higher risks demand high return on capital invested, platforms may have to reduce their use of capital and indirectly cut their R&D investments with negative effects on innovation. The latter could be, however, compensated by the fact that there are still in use extensive R&D tax incentives for innovation in general and digital innovation in particular. This is the argument used by the Commission Impact Assessment: digital platforms and companies are very R&D intensive and get larger benefits from R&D tax incentives than other companies. The counterargument is that digital companies have also a different share of equity finance and pay different rate of return on capital.

Finally, considering digital platforms intermediating labour, the DIT may be transferred also to gig workers and micro-entrepreneurs. Again, it will depend on (i) whether new platforms will emerge applying lower transaction fees to gig workers; and (ii) elasticity of gig labour supply. At any rate, the amount of the labour force using such platforms is still very limited, so the impact might be marginal and amount basically to a return to other forms of NSW that have been used long before digital labour platforms emerged.

After this exemplificative discussion of the uncertainties and speculation needed to assess economic effects, below we present the overall economic reasoning, first starting with the economic logic without interventions, and then considering the possible effects of taxation and labour market interventions.




- Each curve shows how L or K substitute each other while keeping output constant.
- The slope of an isoquant is The Marginal Rate of Technical Substitution (MRTS).

- An isocost line is a Total Cost of production line that recognises all combinations of two resources that a firm can use, given the Total Cost (TC).
- Moving up or down the line shows the rate at which one input could be substituted for another in the input.

FIGURE 6: Isoquants and Isocosts

A starting point is whether a firm decides to externalise or internalise tasks: the make or buy dilemma on which Ronald Coase won the Nobel Prize[148]. A firm (command) reduces transaction costs, while a market reduces organisational costs. Inside the world of manufacturing, under certain conditions private and decentralised negotiation may be too time consuming and costly and a ‘buy’ decision (i.e. outsourcing / offshoring, also through platforms) is more efficient. How would a fully developed Industry 4.0 change this decision? Automation, digitisation, and robotisation allow a re-specification of tasks inside the firm, increasing efficiency, and may increase ‘make’ for certain tasks and ‘buy’ for others at the possible cost of unemployment and inequality: educated workers have comparative advantage in new tasks, unskilled workers may become unemployed or enter into NSW or labour platform intermittent and less protected employment. Outside of the world of manufacturing, assuming increased platformisation, we are replacing allocation of resources through markets with assignment through platforms. So, at any point in time the current technological set characterises the task specification inside manufacturing. Given the set of tasks, the companies decide the assignment between capital and labour for any given wage and profit rate. The balance between automation and labour in manufacturing determines the residual (external to manufacturing) labour supply for other sectors (i.e., services, government), which is likely to be in the form of NSW and to be intermediated by platforms (especially in the service sector, and less so in government).

Let us stress again this aspect for it represents one of the main simplifications we apply. We aim to link the dynamics inside manufacturing and in the residual labour market. The market of interest is mainly for NSW and for platform work, but it residually contains all the labour available in the market that is not absorbed by the manufacturing firms that are assumed to be the main players of Industry 4.0. This is a simplification needed to use a two-dimensional graph (see Figure 6). The interaction between the quantity of labour supply and labour demand, mediated by current institution and norms in bilateral bargaining setup, define the overall wage distribution (i.e. the minimum and maximum wage). Finally, intra capital and intra labour competition and collusion, together with societal norms, determine the shape of the economic distribution of wage-profits (i.e. the frequency of each range of wages and profits rate).

Let us now use some standard economic graphs that are instrumental to proceed and illustrate the overall logic: the ‘Isoquant’ and ‘Isocost’ curves.

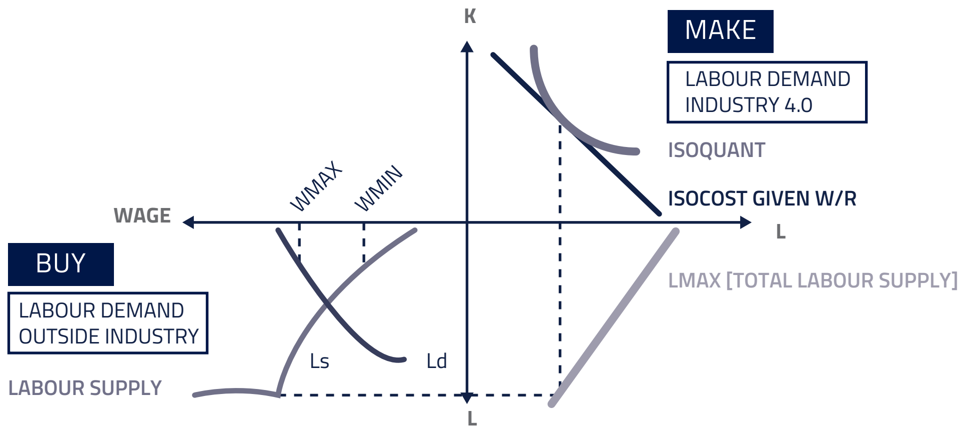



FIGURE 7: Linking workplace and marketplace dynamics

First, on the top left we have the 'isoquant curves' indicating the production outputs given combinations of capital (K) and labour (L). These curves capture the innovation effect. If you increase innovation the curve shifts toward the origin (fewer inputs needed to produce a given output), if you hamper innovation its shift outwards. Each curve represents the level at which specification of tasks and use of machine determines the output frontier. This frontier is not simply a matter of machine and skills but also of the organisational capacity to better specify tasks. Better specified tasks can be better performed by workers or more easily accomplished by machine. Given prices of labour (w) and capital (r), the Isocost curve at the right top of the graph indicates different combinations of K and L that maintain constant the total cost for the company. Given the isoquant, the Isocost curve must be a tangential line that intersects it at the best combination of K and L input given a target output objective. Now let us look at the diagram at the bottom. The black lines indicate the isoquant and Isocost at T0. Now, let's assume that at T1 for some reason the cost of capital relative to labour increases. The new Isocost curve shifts (blue line) and there is a new equilibrium point using more labour and less capital. This is important to consider in order to understand the effects that, given a technological set that characterises the specification of task, various interventions have on how industrial firms assign tasks between capital and labour. On the other hand, the balance between automation and labour induces an external labour supply of Non-Standard Work (NSW) oriented towards platforms (and residually to the non-manufacturing sectors, and to public sector employment).

Let us look at the next graph, focussing on the North East (NE) and on the South West (SW) quadrants. This is a reduction in a two-dimensional space of what would be a four-dimensional analysis, where we make some simplifications to look at how the dynamic of work in manufacturing and the market are linked. Let us be very simple and intuitive. The NE quadrant is the world of Industry 4.0, which means the decisions of manufacturing firms about task specifications and their allocation between labour and machines. The SW quadrant is the residual labour market, which means the residual supply of labour (not hired in the world of Industry 4.0) and the demand for labour from platforms, SMEs, non-manufacturing sectors, the government; a world where we assume NSW is prominent. So, in the SW quadrant we have the supply and demand of labour outside Industry 4.0.

In the NE quadrant we have quantities of labour and capital. In the SW quadrant we have quantities of labour and wage. In the NE quadrant the isoquant represents the current technological set characterising the task specification. Given this set, companies allocate between capital and labour for a given profit (r) and wage (w). Given the decisions by company, the Lmax curve with the slope of -1 gives the total labour available that has not been used by the manufacturing companies of the NE quadrant and that is the total labour supply to be considered in the SW quadrant. This is the total labour supply available for NSW for platforms, SMEs, and micro-enterprises, or that can be hired by government. We can also consider it as the overall residual labour market. It is important to stress the graphic notation: after a certain point the supply of labour becomes flat and would not increase even for increases in wages because there would be no additional labour to supply. In the SW quadrant demand of labour and a supply of labour should determine the equilibrium wage at their intersection. Complicating the picture by considering market frictions, we can assume that the actual equilibrium would be somewhere between a minimum and a maximum. The minimum wage would be under condition of monopsony: only one platform exists where workers can get work; the maximum wage would be under condition of monopoly: imagine a unified union of Uber drivers imposing the wage to the platform. Moreover, how workers concentrate also depends on other factors, including the characteristics of social protection and welfare, which for the moment are black-boxed and will be considered qualitatively later.

First, let us go back to the NE quadrant and consider tax interventions directed to firms. Now we ask the following question: what happens if a new tax affecting firms or the removal of tax incentives for R&D machinery is introduced? The cost of capital relative to that of labour increases and the isocost curve flattens so that the point of equilibrium with the isoquant will entail more labour and less capital. Manufacturing companies will hire more workers, so that the labour supply available in the SW quadrant will decrease. A capital (robot) tax, may hamper innovation and reduce efficiency as more capital and labour are needed for any given output, thus reducing productivity. Under this condition, if the demand for labour remains constant or even increases (i.e. more public investments and more public jobs from using revenues from the new tax), wages should increase in general, and the gap between standard and NSW workers should decrease. On the other hand, as the cost of capital increases this may reduce incentives for technological innovation and the isoquant curve may shift outward (more capital and labour needed for given output). Obviously, a capital (robot) tax or the removal of R&D tax incentives for machinery affect the world of the NE quadrant much more directly, than a digital service tax. As we anticipated earlier, this depends on several uncertain elasticities on the degree to which third-party producers are affected, and also on the degree to which less R&D and innovation by digital platforms and company may delay and/or make more expensive Industry 4.0 innovation.

Let us assume that the impact of the DIT is neutral on the company of the NE quadrant, but will affect digital platforms and firms in all non-industrial sectors. This may reduce the demand for labour in the SW quadrant and, thus, may lead to decrease in wages and possibly a mild increase in the wage differential between standard and NSW workers. Yet, all of this could be compensated by: a) the fact that R&D tax incentives would be retained and benefit disproportionally digital companies; b) that new platforms may emerge that would not shift the tax cost on final consumers and labour market. So, repeating again the speculative nature of this reasoning, we can assume the effect on labour markets would be from neutral to mildly positive, since R&D incentives would still ensure some level of innovation and efficiency gains both for Industry 4.0 and for digital platforms and companies and, thus, having neutral or mildly positive effects on productivity. If we consider instead tax reductions on firms or increased tax breaks for digital innovation investments, the logic is the reverse. Lower corporate taxes in general or increased incentives for R&D in automation and digitisation will increase use of capital, spur innovation, and increase efficiency. Capital becomes relatively less expensive and substitute for labour in the NE quadrant. As a result, the supply of labour in the NW quadrant will increase, while demand will remain either stable or will decrease (tax cuts and increased incentives reduce government resources for investments and jobs creation). This will create unemployment, decrease wages, increase NSW and gig work and the wage differential between standard and non-standard workers. In terms of budgetary implications, it can be assumed that a capital tax will yield more revenues than a digital service tax and of the reduction of R&D tax incentives. Between the DIT and the reduction of R&D tax incentive, it is not possible to say which would yield more revenues. On the other hand, reduction of corporate tax and increase of R&D tax incentive will obviously substantially reduce budget revenues.

Second, let us now consider instead the tax interventions directed at labour: a) cut in the tax wedge on labour compensation; or b) R&D tax incentives to hire qualified personnel. Let us assume that the first are not applied and used across the board, but rather for sectors with labour shortages and in need of more skilled workers and also as incentives to turn NSW into standard contracts. Firms in the NE quadrant will hire more workers, but because capital cost is not increased, they can also continue to invest in technology. Certainly, these interventions will increase man-machine neutrality, so that if it is more efficient to hire a worker, then there will be not tax distortions leading firms to invest in machine instead. Yet, the effect on innovation of relatively cheaper labour is uncertain and a source of controversies. The answer of a heterodox economist would be that, as labour becomes cheaper the incentives for firms to innovate and introduce more efficient machinery (known as the Ricardo effect) would weaken and impact negatively on productivity (produce a negative Ricardo effect). On the other hand, mainstream economists would predict that this regime would favour factors mobility increasing the likelihood that best workers and more capital would go to the most innovative and efficient firms, which in turn positively impact on productivity.

Considering these possible opposing effects, one may at first assume that the net impact on innovation of tax targeting labour will be zero. As manufacturing firms hire more workers (at least to some extent), but especially the more skilled ones, in the SW quadrant the supply of skilled labour will decrease but that of unskilled labour will increase (absorbed by NSW and platforms). If applied across the board, tax cuts on labour would entail substantial costs for the public budget (so no public investments and public sector jobs) and if impact on innovation is assumed to be neutral, without other interventions, the demand for labour will remain stable or decrease. As a result, wages for skilled workers would rise but for unskilled workers would decrease and the differential between standard and non-standard workers will increase. On the other hand, given the selectivity of these measures (only for a few sectors facing shortages or needing highly qualified personnel), the above effects could be moderated. Some public investments may create new jobs, plus the use of skilled personnel may tip the two contrasting effects seen earlier and produce positive effects on innovation and efficiency. In this case labour demand would increase in the SW quadrant, so that wages would increase also for less skilled and non-standard workers, without increase in the wage differential. So, even considering all these uncertainties, we assume these measures do not depress productivity but rather moderately increase it and that they reduce polarisation and inequality effects.

Third and finally, let us now consider what happens with flexicurity or unconditional basic income. The flexi component has the same effects as the previous measures making labour relatively less expensive. So, manufacturing firms use more workers, and the residual part of the labour supply in SW quadrant decreases. In principle, with less labour supply, ceteris paribus, wage should increase. The effects on wages will depend, however, on the demand for labour from platforms and from the public sector. Very important in determining this effect is how the public sector will finance the security component of flexicurity. If the government funds flexicurity by cutting public investments, this will decrease the demand for labour and have negative impacts on wages and inequality. Conversely, if the government funds flexicurity by cutting education and healthcare and/or raising taxes in a way that affects SMEs, micro-enterprise or indirect taxes hitting consumers and shop-keepers (i.e., whereas it cannot tax multinational platforms and digital transactions), this could create political tensions and opposition with increase support for populist and 'sovranist' parties.

There are also two additional questions with flexicurity. First, there are the two opposing views on what happens to innovation and efficiency seen earlier. Since we defined extended flexicurity to have a social investment component with emphasis on training, skills, and active labour market policies, we can expect a limited but positive effect on both productivity and employment. While the cost of labour decreases, the security part may create less incentives for some workers to offer their labour and this may distort the interaction between the demand and supply of labour. So, impacts of flexicurity as such on wages and wages differential remain in principle undetermined, but the social protection part reduces polarisation. If unconditional basic income is introduced, the reservation wage of workers will increase, and labour supply will decrease. The final effect on wages is uncertain since there are opposite forces (depressed labour demand outside industry but also lower supply of labour). On the other hand, since standard employment in industry increases, the wage gap between standard and non-standard or gig workers will also increase. Unconditional basic income makes labour cheaper and manufacturing firms will hire more workers in the NE quadrant. Again, we have the possible opposing effects on innovation and efficiency seen earlier, and as in the case of extended flexicurity we assume a neutral (zero) net impact. As seen in the previous discussion, within a general equilibrium condition labour demand depends on total investment, which is affected by what government does. If the government has to finance unconditional basic income, depending of what tax measures are introduced it may not be able to sustain labour demand. However, workers are receiving basic income, which will increase their opportunity cost of working. This means that their reservation wage is now higher. In labour economics, the reservation wage is the lowest wage rate at which a worker would be willing to accept a particular type of job. So, given basic income, certain low paid jobs will be rejected. Given a process of bargaining with relative strength of both sides, and the elasticity of the demand and supply of labour, the results on the wage distribution are unclear, because the two effects on labour demand and supply go in opposite directions. However, given that workers are now used more inside companies, the wage gap between platforms and standard workers increases.

Yet, supporters of unconditional basic income make two more optimistic assumptions. First, as labour will become extremely cheap, overall labour productivity will decline but the quality of output produced by humans will increase as there will be a stronger and more voluntary choice to work. Robots and automation will be for the cheap goods and services, whereas for instance a 5-star hospital will combine robots and labour-intensive personal service. Second, and related to the previous point. There will be a significant reduction in the supply of labour, so in the case of routine jobs the reservation wage will indeed increase. But this would not hold for all jobs. Jobs entailing autonomy and independence might not have a higher reservation wage at all. Under these two more optimistic hypotheses, there would be less unemployment and also less wage differentials and inequality. Obviously, for this to happen, a big cultural shift in norms is needed in order to manage a society where at any given point in time large segments of the potentially active (and often young) population were not working but living out of unconditional income. Another potential challenge and source of instability is the political acceptance of unconditional basic income. If unconditional basic income reduces other forms of welfare benefits and protection (i.e. education, healthcare, public housing), then the middle class may fight and potentially ally with small capital against this solution, which may further fuel populist causes.

Finally, new data sharing measures and new approaches to competition policy with respect to platforms could certainly have a level playing field effect and increase the perceived fairness of the system. Reasoning by text book economics, increased competition should lead to more innovation and efficiency and, thus, increase both productivity and employment and also reduce polarisation. Yet, to be on the conservative side, we assume these effects to be limited.

The reasoning above, with all its limitation and need for speculative assumptions that we take the occasion to stress again, provides the basics for then making the various instruments interact and for the qualitative assessment of the economic effects of the scenarios presented and also of the various measures presented in Sections 3.2 and 3.3. The next tables illustrate in more details the assessment of the two contending scenarios and of the various measures taken separately.

**TABLE 1** EFFECTS SUMMARY TABLE

| | Productivity | Employment | Level playing | Polarisation effects | Perceived fairness | Political/ instability risks |
|---|---|---|---|---|---|---|
| **Digital Intermediary Tax** | Possibly mild positive effect | Mildly positive | Reduced asymmetry | Mildly positive | Increase (medium) | Big digital players opposition and lobbying; Geopolitical tensions, retaliation. |
| **Capital Tax (CT)** | Hamper innovation and efficiency, thus, lowering productivity. More capital and labour needed for any given level of output | + Employment in industry - labour supply outside industry If demand constant, larger share of standard work | Man-machine neutrality | If demand constant or increases, wage increases, and gaps reduced | Increase (medium) | Industry opposition, possible specific effects on SMEs Tax competition/ capital outflow |
| **Less machine R&D tax incentive** | Same as CT but more moderate | Same as CT but more moderate | Man-machine neutrality | Same as CT, but more moderate | No effect (too technical to receive public attention) | Same as CT but more moderate No instability effects |
| **More machine R&D tax incentive** | + innovation and efficiency> + productivity | Same as above but more moderate | Bias toward machine | Same as above but more moderate | No effect (to technical to receive public attention) | To technical to cause political reaction. No instability risks (on the contrary possible attraction of capital from outside Europe) |
| **More Human side R&D tax incentives** | Opposing effects of cheaper labour, but we assume moderate positive effect | Possible polarised effect on skilled and unskilled | Man-machine neutrality | Possible polarised effect on skilled and unskilled | No effect (too technical to receive public attention) | None (on the contrary possible attraction of skilled workers from outside Europe) |
| **Tax wedge cut on labour** | Same as above | Same as above | Man-machine neutrality | Same as above | Increase | No political risks No instability risks (on the contrary possible attraction of skilled workers from outside Europe) |
| **Flexicurity 4.0** | Same as above, but with mild positive effect | Effect depends on how is financed | Less two-tier labour market | Effect depends on how is financed | Increase | Possible political opposition, no instability risks effects |
| **Less machine R&D tax incentive** | Same as above, but with mild positive effect | Effect depends on how is financed | Unclear | Effect depends on how is financed | Increase | Possible political opposition, no instability risks effects |

**CT**= Capital Tax; **SW**= Standard Work or Standard workers; **NSW**= Non-Standard Work or Non-Standard workers.

**TABLE 2** ASSESSMENT OF THE TWO CONTENDING SCENARIOS

| | Productivity | Social cohesion | Budget effect | Employment | Level playing field | Perceived fairness | Instability risk | Political risks |
|---|---|---|---|---|---|---|---|---|
| **Ultra-social** | 5 | 7 | 1 | 7 | 7 | 7 | 1 | 5 |
| **Ultra liberal** | 7 | 1 | 2 | 3 | 2 | 1 | 4 | 1 |

**TABLE 3** ILLUSTRATION OF THE ASSESSMENT SCALE (BOTH FOR SCENARIO AND MEASURES)

| | Productivity | Social cohesion | Budget effect | Employment | Level playing field | Perceived fairness | Instability risk | Political risks |
|---|---|---|---|---|---|---|---|---|
| **1= strong negative effect** | Decrease | Decrease | Decrease of revenues/ Increase of spending | Increase | Less | Less | More | More |
| **2= medium negative effect** | Decrease | Decrease | Decrease of revenues/ Increase of spending | Increase | Less | Less | More | More |
| **3= weak negative effect** | Decrease | Decrease | Decrease of revenues/ Increase of spending | Increase | Less | Less | More | More |
| **4= No effect** | No net effect | No net effect | Neutral | No net effect | Neutral | Neutral | Neutral | Neutral |
| **5= weak positive effect** | Decrease | Increase | Increase of revenues/ decrease of spending | Decrease | More | More | Less | Less |
| **6=medium positive effect** | Decrease | Increase | Increase | Decrease | More | More | Less | Less |
| **7= strong positive effect** | Decrease | Increase | Increase | Decrease | More | More | Less | Less |

**TABLE 4** ASSESSMENT OF THE SINGLE MEASURES

| | Productivity | Social cohesion | Budget effect | Employment | Level playing field | Perceived fairness | Instability risk | Political risks |
|---|---|---|---|---|---|---|---|---|
| Lower corporate taxes | 7 | 1 | 2 | 3 | 2 | 1 | 4 | 1 |
| Digital Intermediary Tax | 5 | 5 | 6 | 4 | 7 | 7 | 1 | 3 |
| Machinery R&D incentives | 6 | 3 | 3 | 3 | 3 | 4 | 4 | 4 |
| Human side R&D incentives | 6 | 7 | 3 | 6 | 5 | 5 | 4 | 4 |
| Cut of wedge tax on labour | 6 | 7 | 2 | 7 | 6 | 7 | 4 | 4 |
| Extended flexicurity 4.0 | 5 | 7 | 1 | 5 | 7 | 7 | 4 | 2 |
| Data sharing regulation | 5 | 5 | 4 | 5 | 7 | 7 | 2 | 4 |
| New competition regulation | 5 | 5 | 4 | 5 | 7 | 7 | 1 | 4 |

# LIST OF ACRONYMS WITH EXPLANATION

| | |
|---|---|
| **AI** | Artificial Intelligence - in this report often used for the collection of new technologies including IoT, ML, Robotics |
| **CPS** | Cyber Physical Systems - systems integrating computation and digital processes, in which the embedded computers and networks monitor and control the physical processes |
| **DIT** | Digital Intermediary Tax – a tax on: (i) online advertising, (ii) seller/buyer fees transacted via online intermediaries and marketplaces and (iii) the sale of user data |
| **DST** | A tax proposed by the EC which is similar to DIT. As proposed by the EC it is rejected by the EU Council in December 2018 |
| **EC** | European Commission |
| **ECJ** | European Court of Justice |
| **EP** | European Parliament |
| **EU** | European Union |
| **Flexicurity 4.0** | Labour flexibility in regulation of contracts, plus social security (linked to the person, not the job) and extended to include all social benefits (e.g. education, health care, ...) |
| **GC** | General Court |
| **IoT** | Internet of Things |
| **MEP** | Member of European Parliament |
| **ML** | Machine Learning – an AI technology for autonomous learning by machines |
| **MSP** | Multi-Sided Platforms, platforms including more than two types of players. Two-sided platforms generally include sellers and buyers matched by the platform. A MSP, besides buyers and sellers, may also include producers, developers, advertisers, etc. Uber is a typical two sided platform, whereas Google, Facebook, Apple, and Amazon are multi-sided (and integrated) platforms |
| **NSW** | Non-Standard Work – types of employment different from the standard employment contract, e.g. temporary contracts, freelance work, mini jobs, vouchers, 'zero-hour contracts', and small jobs being intermediated through digital labour platforms. |
| **RBTC** | Routine Biased Technological Change |
| **SBTC** | Skill Biased Technological Change |

# NOTES

[1] See: Schwab, K. (2016). The Fourth Industrial Revolution. Geneva: World Economic Forum; Schwab, K. (2018). Shaping the Fourth Industrial Revolution. Geneva: World Economic Forum.

[2] European Political Strategy Centre (2017). Enter the data economy. EU Policies for Thriving Data Ecosystem. Issue 21, p. 1

[3] These policies are comparatively reviewed in European Commission, (2017a). Key lessons from national industry 4.0 policy initiative in Europe. Digital Transformation Monitor. Brussels: European Commission. Country insights can be found in other issues of this monitor such as for instance: European Commission (2017b). Germanie: Industrie 4.0. Digital Transformation Monitor. Brussels: European Commission; European Commission (2017c). France: Industrie du Futur. Digital Transformation Monitor. Brussels: European Commission; European Commission (2017d). Italy: "Industria 4.0". Digital Transformation Monitor. Brussels: European Commission.

[4] See: People's Republic of China (2018), White Paper of Regulation and standardisation of Artificial Intelligence ( ); People's Republic of China (2018), New Generation of Artificial Intelligence Development Plan ( ).

[5] Ever since in 2011 President Obama announced the formation of the "Advanced Manufacturing Partnership (AMP), a national effort bringing together industry, universities, and the federal government to invest in the emerging technologies that will create high quality manufacturing jobs and enhance our global competitiveness." (https://obamawhitehouse.archives.gov/the-press-office/2011/06/24/president-obama-launches-advanced-manufacturing-partnership). AMP development was based on the recommendation of the President's Council of Advisors on Science and Technology (PCAST), which released a report entitled "Ensuring Leadership in Advanced Manufacturing."(https://obamawhitehouse.archives.gov/the-press-office/2015/11/30/ensuring-american-leadership-advanced-manufacturing ).

[6] See: Government of the Republic of Korea, (2016) Intelligence Information Society Mid and Long-term Policy Vision; Commission for Forth Industrial Revolution (2018), Ministry of Science and Innovation Policy, Research and Development Plan for Forth Industrial Revolution.

[7] See for instance Hermann, M., Pentek, T. and Otto, B. (2015). Design Principles for Industrie 4.0 Scenarios: A Literature Review. Working Paper No. 01 / 2015, Technische Universität Dortmund.

[8] See the various essays on digital transformation and work in Neufeind, M., O'Reilly, J and F. Ranft (Eds.), Work in the Digital Age: Challenges of the Fourth Industrial Revolution. Rowman & Littlefield: London.

[9] Artificial intelligence (AI) that can be defined as the capability of a machine to imitate intelligent human behaviour or as an agent's ability to achieve goals in a wide range of environments. AI is the latest form of processes of automation that have been ongoing for at least 200 years (see Aghion, F., & Jones, P. (2018). Artificial Intelligence and Economic Growth. In A. Agrawal & A. Goldfarb (Eds.), The Economics of Artificial Intelligence: An Agenda, chap. 9. Chicago: University of Chicago Press). This latest form of automation in human history concerns the digitisation of production processes (see Peruffo, E., Contreras, R., Molinuevo, D., & Schmidlechner, L. (2017a). Digitisation of processes: Literature Review. Dublin: Eurofound, p. 2).

[10] Gubbi, J. Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. Future Generation Computer Systems, 29 (7), 1645-1660.

[11] Direct network effects are where more users generate more users, as in more Facebook. Indirect network effects are where more users of one side of the platform attracts more users on the other side of the platform as video game users attract developers.

[12] Evans, P., & Gawer, A. (2016). The Rise of the Platform Enterprise. A Global Survey. New York: The Center for Global Enterprise, pp. 5-5

[13] Evans, P., & Gawer, A. (2016). The Rise of the Platform Enterprise. A Global Survey, op. cit., p. 9.

[14] See Guellec, D., & Paunov, C. (2017). Digital Innovation and the Distribution of Income. NBER Working Paper No. 23987). The authors explain and document empirically how digital innovation enables massive economy of scale (scale without mass), network effects, and reduction to zero of marginal costs. The initial production and launch of digital service, being it a software or a successful digital platform, requires large investments. Yet, after this investment is done, the cost of producing each additional unit of the service (in technical term of marginal cost) is zero or close to zero. Once a new version of a software is produced, producing and selling one copy or 1000 copies is hardly different. This also means increased fluidity and reduction of frictions and barriers. But digital non-rivalry and fluidity may have opposite effects: 'more market entries' versus 'winners take all effects'. The authors bring empirical evidence showing that the second effect has prevailed so far, and that digital innovation often produces concentration of power, extraction of rents, and is associated with the rising inequality of the last three decades. The non-rivalry means that a good can be consumed by one consumer without preventing consumption by others. Knowledge and information are non-rival goods par excellence. Digital innovation is fully intangible and non-rival and is not physically constrained. Digitalised innovations are easier to handle. Beyond the initial cost to produce the original they have very low or zero cost for reproduction, communication, lower search costs, and more fluidity with low friction costs.

[15] See for instance: Hildebrandt, M. (2018). Primitives of Legal Protection in the Era of Data-Driven Platforms. Georgetown Law Technology Review, 2, 252-273; Cohen, J. (2016), The Regulatory State in the Information Age, Theoretical Inquiries in Law, 17, 369-414.

[16] European Commission, (2017e). Digitising European Industry: Working Group 2 – Digital Industrial Platforms, Final Report. Brussels: European Commission, DG CONNECT, p. 14 (adapted from: http://platformed.info/platform-stack/ ).

[17] Tata Communication, (2018). Cognitive Diversity: AI & The Future of Work.

[18] Friedman, G. (2014). Workers without employers: Shadow Workers and the rise of the gig economy. Review of Keynesian Economics, 2(2), 171-188.

[19] European Parliament (2016). Industry 4.0. Directorate General for Internal Policies. Policy Department A: Economic and Scientific Policy, p. 8.

[20] Digital innovation and transformation they may impact the equilibrium of our free market democratic social fabric and order. In other terms, what the French School of Regulation calls the Mode of Regulation (MR). A MR is that ensemble of institutional, normative, cultural, and regulatory components that ensure the reproduction of economy and society. In complex modern systems there are forces at work that keep such systems together and thick, make them grow despite rapid and profound modifications of their industrial structures, social relations, techniques of production, patterns of consumption. We probably live in the first social structure where constant technological, social and economic change is a fundamental feature of its functioning. Changes and transformation are by nature dis-equilibrating. There must be factors and mechanisms that maintain relatively ordered configurations of the system and allow a broad consistency between the conditions of material reproduction (including income distributions, accumulation, available techniques, patterns of consumption) and the thread of social relations.

[21] European Commission. (2016a). Digitising European Industry Reaping the full benefits of a Digital Single Market. COM (2016) 180 final, Brussels: European Commission.

[22] European Parliament, Committee on Legal Affairs, Rapporteur Mady Delvaux, Draft Report with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)), 31.05.2016 (http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML%2BCOMPARL%2BPE-582.443%2B01%2BDOC%2BPDF%2BV0//EN ), p. 4.

[23] European Parliament (2016). Industry 4.0, op. cit., p. 8.

[24] Rather than talking about the classic intra-capital fractures (i.e., financial versus industrial, big versus small) the main line of cleavage emerging is that between capital vs data services, in a capitalism without capital, see Haskell, J. (2018). Capitalism without Capital: The Rise of the Intangible Economy. Princeton: Princeton University Press.

[25] Reviews can range from unstructured and fairly subjective in the selection of sources (i.e. narrative reviews) to very structured along the lines of the Cochrane protocol (see Higgins, I., & Green, S. (Eds.). (2011). Cochrane handbook for systematic reviews of interventions. Version 5.1.0. West Sussex, England: The Cochrane Collaboration and John Wiley & Sons Ltd). They can be comprehensive but with a narrow vertical but longitudinal focus including only empirical items (i.e. systematic review) and sometimes only quantitative empirical items (meta-analysis). Scoping and critical reviews, on the other hand, have a broader focus and us less restrictive criteria for the inclusion of sources in the analysis (see for a review and typology of different reviews approaches: Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. Health Information and Libraries Journal, 26(2), 91-108; Paré, G., Trudel, M.-C., Jaana, M., & Kitsiou, S. (2015). Synthesizing information systems knowledge: A typology of literature reviews. Information & Management, 52(2), 183-199. Scoping and/or critical reviews are undertaken when: a) researchers are entering a new field and/or the field is known to be emergent and not fully consolidated; and b) the focus of analysis is not vertical and specific but broad, cross-sectional, and inter-disciplinary. This was evidently the case of this study. So, the work was conducted as a scoping/critical review where contributions could either be empirical-analytical or conceptual/prescriptive or of a foresight nature. The inclusion criterion has been simply that they deal with at least one of the dimensions of analysis characterising the framework adopted in the study. Given the short-time frame the search strategy was based on a snow-ball approach, rather than going through the various phases required to first run a Boolean search with key terms, then assess the broad numbers of potential contributions, and finally select those to be reviewed. The more pragmatic snowballing approach consisted in identifying a few important and validated sources and derive from their contents other items that were included in the review. As a result, the study is based on: a) 'analytical-empirical' articles and papers where hypotheses of a model are tested with empirical data ; b) 'conceptual essays' that, though using and commenting information and evidence, are mainly theoretical and/or speculative as a result of disciplinary traditions ; c) 'prescriptive' industry reports (mostly by consulting companies but also by industrial associations) envisaging the benefits of new technological capabilities and providing recipes of what firms and government should do to realised them; d) 'futuristic and/or foresights' contributions constructing scenarios and roadmaps following consolidated methodologies; e) 'institutional reports and documents' such as reports released by the Commission, The European Parliament, communications by the Commission, national strategies, and reports released by national governments

[26] https://www.gartner.com/en/newsroom/press-releases/2017-08-15-gartner-identifies-three-megatrends-that-will-drive-digital-business-into-the-next-decade

[27] See definition by the Commission at: http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf.

[28] Eurofound, (2017). The Impact of Advanced Industrial Robotics on European Manufacturing: Taking Human-Robot Collaboration to the next Level. Dublin: Eurofound.

[29] Reported in Buhr, D. (2017), Social Innovation Policy for Industry 4.0, op. cit. , p. 6.

[30] International Federation of Robotics (2016), World Robotics 2016, available at: https://ifr.org/worldrobotics/; International Federation of Robotics (2017), World Robotics 2017, available at: https://ifr.org/downloads/press/Executive_Summary_WR_2017_Industrial_Robots.pdf; power point presentation with summary data available at https://ifr.org/downloads/press/Presentation_PC_27_Sept_2017.pdf.

[31] European Commission (2016b), Analysis of the Impact of Robotic Systems on Employment in the European Union – Update, Publications Office of the European Union, Luxembourg, p. 3.

[32] Peruffo, E., Schmidlechner, L., Contreras, R., & Molinuevo, D. (2017a). Automation of work: Literature Review. Dublin: Eurofound, p. 6.

[33] European Commission, (2017a). Key lessons from national industry 4.0 policy initiative in Europe, op. cit., p. 2.

[34] European Commission, (2017a). Key lessons from national industry 4.0 policy initiative in Europe, op. cit., p. 8.

[35] European Political Strategy Centre (2017). Enter the data economy. EU Policies for Thriving Data Ecosystem. Issue 21, p. 4

[36] Commission Staff Working Document SWD (2016) 187 final: 'Europe's Digital Progress Report 2016', 25 May 2016.

[37] European Parliament (2016). Industry 4.0., op. cit., p. 8.

[38] Graumann, S., I. Bertschek, T. Weber et al. (2015), Monitoring-Report. Wirtschaft DIGITAL 2015, Bundesministerium für Wirtschaft und Energie, Berlin (Reported in Arntz et al, op. cit., p. 22).

[39] ZEW (2015), "IKT-Report. Unternehmensbefragung zur Nutzung von Informations- und Kommunikationstechnologien" [ICT Report. Company Survey on the Use of Information and Communication Technologies], October 2015, Zentrum für Europäische Wirtschaftsforschung, Mannheim (Reported in Arntz et al, op. cit., p. 22).

[40] Reported in Buhr, D. (2017), Social Innovation Policy for Industry 4.0, op. cit., p. 7 (Data from Klein, Michael; Acatech (Deutsche Akademie der Technikwissenschaften) 2014: Das Zukunftsprojekt Industrie 4.0, Presentation at the FES expert discussion on Industry 4.0, 21.5.2014, Berlin.

[42] See: European Commission, (2017a). Key lessons from national industry 4.0 policy initiative in Europe, op. cit. Country insights can be found in other issues of this monitor such as for instance: European Commission (2017b). Germanie: Industrie 4.0. Digital Transformation Monitor. Brussels: European Commission; European Commission (2017). France: Industrie du Futur. Digital Transformation Monitor. Brussels: European Commission; European Commission (2017c). Italy: "Industria 4.0". Digital Transformation Monitor. Brussels: European Commission. See also European Commission, (2017e). Digitising European Industry: Working Group 2 – Digital Industrial Platforms, Final Report, op. cit.

[43] Evans, P., & Gawer, A. (2016). The Rise of the Platform Enterprise. A Global Survey, op. cit.

[44] Reported in Degryse, C. (2016). Digitalisation of the economy and its impact on labour markets. ETUI, Working Paper 2016.02, pp. 12-13.

[45] Frey, C., & Osborne, M. (2013). The Future of Employment: How Susceptible Are Jobs to Computerisation? Oxford Martin School Working Paper. Oxford. Later published as Frey, C., & Osborne, M. (2017). The future of employment: How susceptible are jobs to computerisation? Technological Forecasting and Social Change, 114, 254-280

[45] Arntz, M., T. Gregory and U. Zierahn (2016). The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis. OECD Social, Employment and Migration Working Papers, No. 189, OECD Publishing, Paris.

[46] City Bank and University of Oxford, (2016). Technology at Work v2.0. The Future Is Not What it Used to be (https://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work_2.pdf )

[47] Nedelkoska, L. and G. Quintini (2018). Automation, skills use and training, OECD Social, Employment and Migration Working Papers, No. 202, Paris: OECD Publishing (https://www.oecd-ilibrary.org/docserver/2e2f4eea-en.

[48] See the table comparing various estimates reported in Winick, E. (2018). Every study we could find on what automation will do to jobs, in one chart. MIT Technology Review, January 25 (https://www.technologyreview.com/s/610005/every-study-we-could-find-on-what-automation-will-do-to-jobs-in-one-chart/ ). The data produced by Winick are rendered into a telling graph in Ghaffary, S. (2018). Why no one really knows how many jobs automation will replace. Recode, October 20 (https://www.recode.net/2018/10/20/17795740/jobs-technology-will-replace-automation-ai-oecd-oxford ).

[49] See McKinsey Global Institute, (2017a). Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation; McKinsey Global Institute, (2017b). A Future That Works: Automation, Employment, and Productivity;

[50] See https://www.mddionline.com/billions-jobs-disappear-2030-what-does-mean-manufacturing

[51] John Von Neumann is often cited as first suggesting a coming singularity in technology. In particular, Stanislaw Ulam (May 1958 "Tribute to John von Neumann". 64, #3, part 2. Bulletin of the American Mathematical Society: 5.) reports a discussion with John von Neumann 'centered on the accelerating progress of technology and changes in the mode of human life, which gives the appearance of approaching some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue'. The idea was later popularised Ray Kurzweil (The Singularity is Near, New York: Penguin, 2005).

[52] For critical appraisals of the singularity thesis from an economic perspective see: Aghion & Jones Artificial Intelligence and Economic Growth, op. cit. and also Nordhaus, D. (2015). Are we Approaching an Economic Singularity? Information Technology and the Future of Economic Growth. NBER Working Paper, 21547.

[53] The current debate on the effects of AI on the labour market is rooted in economics and economic history literature on the relation between technical innovation and employment dating more than two centuries (For a review see Pianta, M. (2004) Innovation and Employment, in Fagerberg, J., Mowery, D. C., & Nelson, R. R. (Eds.), The Oxford Handbook of Innovation. Oxford: Oxford University Press, chap. 21). Adam Smith pointed out how machines could help favour the division of labour with labour-saving effects; David Ricardo thought that the economy could compensate the loss of jobs and de-skilling caused by mechanisation but added that machinery is no doubt detrimental to the 'labouring class'; Karl Marx was critical about the compensation theory and considered loss of jobs, de-skilling, and loss of control by workers on their own work a structural effect of mechanisation; also Joseph Schumpeter considered structural technological unemployment a possibility. As a result, there is no dearth of hypotheses and models, as well as recent applied econometric estimations (see Technical Annex). Looking at economic history and at the history of economic thought it is easy to see how the prediction of prominent economists (for instance John Maynard Keynes in the 1930s and Wassily Leontief in the 1970s) about technology causing structural unemployment were not confirmed, as commented by Acemoglu, D. & Restrepo, P. (2018). The Race between Man and Machine: Implications of Technology for Growth, Factor Shares, and Employment. American Economic Review, 108(6), 1488-1542).

[54] For a review of such mechanisms see: Vivarelli, M. (1995). The economics of Technology and Employment: Theory and Empirical Evidence. Aldershot: Elgar; Simonetti, R., Taylor, K., and Vivarelli, M. (2000). Modelling the Employment Impact of Innovation: Do Compensation Mechanisms Work? In Vivarelli, M. and

Pianta, M. (eds.), The Employment impact of Innovation. London: Routledge.

[55] On this aspect see for instance: De Stefano, V. (2016). The rise of the 'just-in-time workforce': On-demand work, crowdwork and labour protection in the 'gig-economy, Geneva: ILO; Eichhorst, W. (2017), Labor Markets Institutions and the Future of Work: Good Jobs for All?", IZA Policy Paper, Vol. No. 122; Eichhorst, W., Hinte, H., Rinne, U. and Tobsch, V. (2016), "How Big Is the Gig? Assessing the Preliminary Evidence on the Effects of Digitalization on the Labor Market", IZA Policy Paper No. 117.

[56] Eurofound. (2015). New forms of employment. Luxembourg: Publications Office of the European Union. This report identified the following new forms of employment: a) employee sharing, where an individual worker is jointly hired by a group of employers to meet the HR needs of various companies, resulting in permanent full-time employment for the worker; b) job sharing, where an employer hires two or more workers to jointly fill a specific job, combining two or more part-time jobs into a full-time position; c) interim management, in which highly skilled experts are hired temporarily for a specific project or to solve a specific problem, thereby integrating external management capacities in the work organisation; d) casual work, where an employer is not obliged to provide work regularly to the employee, but has the flexibility of calling them in on demand; this form of on-call work involves a continuous employment relationship maintained between an employer and an employee, but the employer does not continuously provide work for the employee. Rather, the employer has the option of calling the employee in as and when needed. There are employment contracts that indicate the minimum and maximum number of working hours, as well as so-called 'zero-hours contracts' that specify no minimum number of working hours, and the employer is not obliged to ever call in the worker. This employment form has emerged or been of increasing importance over the last decade in Ireland, Italy, the Netherlands, Sweden and the UK; e) ICT-based mobile work, where workers can do their job from any place at any time, supported by modern technologies; f) voucher-based work, where the employment relationship is based on payment for services with a voucher purchased from an authorised organisation that covers both pay and social security contributions; g) portfolio work, where a self-employed individual works for a large number of clients, doing small scale jobs for each of them; h) crowd employment, where an online platform matches employers and workers, often with larger tasks being split up and divided among a 'virtual cloud' of workers; i) collaborative employment, where freelancers, the self-employed or micro enterprises cooperate in some way to overcome limitations of size and professional isolation.

[57] OECD. (2015a). In It Together: Why Less Inequality Benefits All. Paris: OECD Publishing, pp. 147-170.

[58] The European Union (EU) has adopted three measures concerning 'atypical' workers: (1) a Social Partners' Agreement on part-time work (Directive 97/81concerning the framework agreement on part-timework concluded by ETUC, UNICE and CEEP [1998] OJ L14/9; extended to the UK by Directive 98/23 [1998] OJ L131/10; (2) a Social Partners' Agreement on fixed-term work (Directive 1999/70 concerning the framework agreement on fixed-term work concluded by ETUC, UNICE and CEEP [1999] OJ L175/43); (3) a Directive on temporary agency work known as the 'agency work Directive' (Directive 2008/104 [2008] OJ L327/9. Member States had to apply this Directive by 5 December 2011: Art 11(1)).

[59] OECD. (2015a). In It Together, op. cit., p. 137.

[60] PwC, (2018). Industry 4.0. How digitization makes the supply chain more efficient, agile, and customer-focused, p. 12.

[61] On this duality of platforms see, among others, the following authors: Fernández-Macías, E. (2017), Automation, Digitisation and Platforms: Implications for Work and Employment, Dublin: Eurofound; Schmidlechner, L., Peruffo, E., Contreras, R., & Molinuevo, D. (2017). Coordination by platforms: Literature Review. Dublin: Eurofound. Sundararajan, A. (2016), The Sharing Economy: The End of Employment and the Rise of Crowd-Based Capitalism, Cambridge: MIT Press.

[62] Hildebrandt, M. (2018). Primitives of Legal Protection, op. cit.; Cohen, J. (2016), The Regulatory State in the Information Age, op. cit.

[63] Rosen, S. (1981), "The economics of superstars", The American Economic Review, Volume 71(5), pp. 845-858.

[64] European Commission. (2016). Digitising European Industry, op. cit.; European Commission. (2018). Artificial Intelligence for Europe. COM (2018) 237 final, Brussels: European Commission.

[65] See Shelanski, H. (2013). Information, Innovation and Competition Policy for the Internet. University of Pennsylvania Law Review, 161 (6), 1663-1705.

[66] Guellec, D., & Paunov, C. (2017) Digital Innovation and the Distribution of Income, op. cit.

[67] Boston Consulting Group, (2015a). Industry 4.0, op. cit., and Boston Consulting Group, (2015b). Man and Machine in Industry 4.0 How Will Technology Transform the Industrial Workforce Through 2025.

[68] Reported in Buhr. (2017). Social Innovation Policy for Industry 4.0. Berlin: Friedrich-Ebert-Stiftung, p. 6.

[69] European Political Strategy Centre (2017). Enter the data economy, op. cit., p. 1.

[70] For instance, see: Brynjolfsson, E., Hitt, L. M. and Kim, H. H. (2011). Strength in numbers: How does data-driven decision making affect firm performance? SSRN 1819486.

[71] Tata Communication, (2018). Cognitive Diversity: AI & The Future of Work.

[72] Goldberg, Ken. "The Robot-Human Alliance." The Wall Street Journal, Dow Jones & Company, 11 June 2017, http://www.wsj.com/articles/the-robot-human-alliance-1497213576 .

[73] European Parliament (2016). Industry 4.0. op. cit., p.4.

[74] Guellec, D., & Paunov, C. (2017) Digital Innovation and the Distribution of Income, op. cit. The line of argumentation, fully backed by empirical data, can be summarized as follows. Digital non-rivalry creates rents from market power and economies of scale in highly concentrated 'winner takes all' markets. Yet, as digital innovation is fluid, less costly, and faster it also increases risks. Even only marginally superior offerings can displace incumbents and take all the market, so moving not to a more competitive equilibrium but rather from one winner to another. As risk increases and market share is unstable, market premium is expected by investors and higher revenues. So, the extraction of market rents is needed to compensate costs, incentivize innovation, and repay capital risks. Beyond a certain level, though, and when the winner is consolidated this rent extraction turn into rent-seeking that substitute innovation and business strategy. As a result, the extracted rents accrue mostly, if not only, to capital investors, as well as to top executives and key employees of the "winning firms" who often own capital and hold managerial and leading positions in firms. Data presented Guellec & Paunov show that the share of capital compared to that of labour has increase especially in economic activities where digital innovation is relatively more intense.

[75] Phelps, E. (2007). Rewarding Work. Cambridge, Mass: Harvard University Press.

[76] European Parliament, Committee on Legal Affairs, Rapporteur Mady Delvaux Draft Report with recommendations to the Commission on Civil Law Rules on Robotics, op. cit. p. 3.

[77] Abbot, R. & Bogenschneider, B. (2018). Should Robots Pay Taxes? Tax Policy in the Age of Automation. Harvard Law & Policy Review, 12: 145-175.

[78] Colin, N & Palier, B. (2015). The Next Safety Net. Social Policy for a Digital Age. Foreign Affairs. July-August Issue, p. 29.

[79] Floridi, L. (2014). The Fourth Revolution: How The Infosphere is Reshaping Human Reality. Oxford: Oxford University Press.

[80] Hildebrandt, M. (2018). Primitives of Legal Protection, op. cit.; Cohen, J. (2016), The Regulatory State, op. cit, Floridi, L. (2014). The Fourth Revolution: How The Infosphere is Reshaping Human Reality. Oxford: Oxford University Press; Floridi, L., ed. (2014). The Onlife Manifesto: Being Human In A Hyperconnected Era. New York: SpringerOpen.

[81] Manjoo, F. (2016a) Tech's "Frightful 5" Will Dominate Digital Life for Foreseeable Future. New York Times, Jan 20; Manjoo, F. (2016b). Why the World Is Drawing Battle Lines Against American Tech Giants. New York Times. June 1.

[82] European Commission, (2017a). Key lessons from national industry 4.0 policy initiative in Europe, op. cit. Main findings of this report can be summarised as follows. These initiatives are generally part of broader overarching framework that are part of industrial policy and/or R&D policy depending on national contexts (i.e., in France it was the significant underinvestment and problems in developing digital industries; in the Netherlands the relative low share of employment linked to the manufacturing sector). Despite country differences, a common denominator is that the main objectives are improving industrial competitiveness and modernisation. Social and environmental objectives are not always present in these initiatives, and when they are the come after industrial and economic objectives. Differences among countries are mostly tactical about how to achieve the main goals. Higher productivity and efficiency figure prominently, but strategies also aim at: supporting the implementation of next-generation technologies (Italy, UK), transforming industrial process and developing new products developing new products (Germany, Italy), help SMEs innovating and commercialising innovation (UK, France and Spain). Only Italian CFI has a strong focus on research (development of new technologies to meet the challenges of manufacturing innovation), while other national policies aim mainly at accelerating the deployment and application of I4.0 technologies. There is not a focus on a specific sector or technology; only German and French policies specifically target IoT and Cyber-Physical systems. Differences are also evident as to whether a market-based approach prevails or public funding is dominant. France and Spain, for instance, provide loans to companies that participate in the programme. Sweden's initiative is heavily driven and financed by industry ensuring industrial impact and long-term sustainability. Public funding is often present but in combination complementary private investments are important, due to a considerable leverage effect. Tax incentives have been used in Italy but not in most other countries.

[83] Buhr, D., Christ, C., Frankenberger, R., Fregin, M.-C., Schmid, J. and Trämer, M. (2016), On the Way to Welfare 4.0? Digitalisation of the Welfare State in Labour Market, Health Care and Innovation Policy: A European Comparison, Friedrich-Ebert-Stiftung, Berlin. But see also the papers collected Neufeind, M., O'Reilly, J and F. Ranft (Eds.), Work in the Digital Age, op. cit.

[84] Colin, N & Palier, B. (2015). The Next Safety Net. Social Policy for a Digital Age. Foreign Affairs. July-August Issue, pp. 32-33.

[85] West, D.M. (2015), What Happens If Robots Take the Jobs? The Impact of Emerging Technologies on Employment and Public Policy, Center for Technology Innovation at Brookings, Washington, DC.

[86] For a review of social investment and social protection policies in Europe see, respectively, these two reports published by the European Commission: European Social Policy Network, (2015). Social Investment in Europe: A Study of National Policies. Brussels: European Commission; Social Protection Committee, (2015). Social protection systems in the EU: financing arrangements and the effectiveness and efficiency of resource allocation. Brussels: European Commission.

[87] Technological change is increasing the productivity of highly skilled workers but creating more challenging labour-market conditions for their low-skilled counterparts. These pressures are likely to grow, especially in light of progress being made in robotisation and automation. The labour force, therefore, needs upskilling also when in employment to keep ahead of the race with technology. To maintain or acquire valuable skills, workers of all ages will need to engage

more in lifelong learning. Some will need to retrain when their occupation becomes obsolete. Unemployment should be conceived mostly as a temporary short-term status and possibly an opportunity to change and not as a permanent status in need of long term benefits or dependency.

[88] See the most recent debate on this topic in the volume edited by Van Parijs, P. (2018). Basic Income and the Left. A European Debate. Brussels: Social Europe Limited.

[89] Peruffo, E., Schmidlechner, L., Contreras, R., & Molinuevo, D. (2017a). Automation of work: Literature Review. Dublin: Eurofound, p. 17.

[90] Soete, L. (2018). Destructive creation: explaining the productivity paradox in the digital age, in Neufeind, M., O'Reilly, J and F. Ranft (Eds.), Work in the Digital Age: Challenges of the Fourth Industrial Revolution. Rowman & Littlefield: London, p. 33.

[91] See https://english.rvo.nl/subsidies-programmes/wbso

[92] European Parliament, Committee on Legal Affairs, Rapporteur Mady Delvaux, Draft Report with recommendations to the Commission on Civil Law Rules on Robotics, op.cit.

[93] See Gates interview with Quartz published 17 February 2017 (https://qz.com/911968/bill-gates-the-robot-that-takes-your-job-should-pay-taxes/ )

[94] See Reuters "European parliament calls for robot law, rejects robot tax", 16 February 2017 (https://www.reuters.com/article/us-europe-robots-lawmaking/european-parliament-calls-for-robot-law-rejects-robot-tax-idUSKBN15V2KM ).

[95] Abbot, R. & Bogenschneider, B. (2018). Should Robots Pay Taxes? Op. cit.

[96] See Sung-won, Y. "Korea takes first step to introduce 'robot tax'", The Korea Times, 7 August 2017 (http://www.koreatimes.co.kr/www/news/tech/2017/08/133_234312.html )

[97] See: OECD, (2018). OECD Review of National R&D Tax Incentives and Estimates of R&D Tax Subsidy Rates, 2017. Paris: OECD publishing; OECD, (2018). 2017 OECD R&D tax incentive country profiles, 2017. Paris: OECD publishing; OECD, (2017). Compendium of R&D Tax Incentive Schemes: OECD Countries and Selected Economies, 2017. Paris: OECD publishing.

[98] Abbot, R. & Bogenschneider, B. (2018). Should Robots Pay Taxes? Op. cit.

[99] European Commission. (2018a). 'Proposal for a Council Directive – laying down the rules relating to the corporate taxation of a significant digital presence' COM (2018) 147 final, Brussels: European Commission; European Commission. (2018b). 'Proposal for a Council Directive on the common system of a digital services tax on revenues resulting from the provision of certain digital services' COM (2018) 147 final, Brussels: European Commission. See also the dedicated dossier in the section Taxation and Custom Union of The European Commission website (https://ec.europa.eu/taxation_customs/business/company-tax/fair-taxation-digital-economy_en ).

[100] Soete, L. & Kamp, K. (1996). The 'bit tax': the case for further research. Science and Public Policy. 23 (6) 353-360.

[101] The simplification entails several aspects. First, the geographic unit of analysis is EU28 as a whole and, therefore, we assume EU wide streamlined interventions on the two dimensions of taxation and labour market regulation. Second, although we assume digital platforms to play a key role in the future, they are to some extent treated residually in the discussion of the scenarios for the process of platformisation cannot be directly tackled only through taxation and labour market regulation. Third, the assessment of the scenarios is based mainly on the analysis of what happen inside manufacturing firms (their decision of allocation of tasks between capital and labour) as it is further explained in Section 4.5 of the Technical Annex. Other parts and sector of the economy are also considered residually. Finally, the economic and distributional effects (i.e., on productivity by way of

innovation and efficiency, on employment, on polarising effects through wages, as well as on the public budget) of the scenarios are assessed qualitatively in terms of broad-brush trends and direction of change, although using a sound economic reasoning (again see Section 4.5 of the Technical Annex). Ex ante the precise assessment and quantification of such effects it is extremely challenging. These effects result from the interaction between the interventions themselves, several ex ante unknown elasticities (of consumer demand, of labour supply, of labour demand), and sectorial and players heterogeneity shaping heterogenous behaviours.

[102] Guellec, D., & Paunov, C. (2017) Digital Innovation and the Distribution of Income, op. cit., p. 34. According to Guellec & Paunov fiscal policy is the most direct instrument to reduce inequalities, including those produced by digital transformation. They see curbing tax elusion and evasion by digital business as legitimate and needed, as as well as attempts to tax market rents that come from non-productive activities. They warn though, that it would be difficult to distinguish non-productive from productive and innovative activities, with a danger of deterring innovation. They conclude that eliminating the condition creating such rent through competition policy may be easier and more effective.

[103] Guellec, D., & Paunov, C. (2017) Digital Innovation and the Distribution of Income, op. cit., p. 35. But see also earlier cited contributions such as: Hildebrandt, M. (2018). Primitives of Legal Protection, op. cit.; Cohen, J. (2016), The Regulatory State in the Information Age, op. cit.; Shelanski, H. (2013). Information, Innovation and Competition Policy for the Internet, op. cit.; Floridi, L. (2014). The Fourth Revolution: How The Infosphere is Reshaping Human Reality, op. cit.

[104] As reported by Guellec & Paunov, 'recent work by the German and French competition authorities goes in this direction (op. cit, p. 35). They refer, for instance, to these two reports: Bundeskartellamt (2016), Market Power of Platforms and Networks, Working Paper Ref. B6-113/15; Autorité de la concurrence and Bundeskartellamt (2016), Competition Law and Data (http://www.autoritedelaconcurrence.fr/doc/reportcompetitionlawanddatafinal.pdf).

[105] European Commission, (2018) 'On the road to automated mobility: An EU strategy for mobility of the future. COM(2018)283 final, Brussels: European Commission.

[106] For a wide review of definitions and analysis of platforms in the economic literature see: Codagnone, C., Karatzogianni, A., & Matthews, J. (2018). Platform Economics: Rhetoric and Reality in the 'Sharing Economy'. Emerald Publishing, chap. 1; Schmidlechner, L., Peruffo, E., Contreras, R., & Molinuevo, D. (2017). Coordination by platforms: Literature Review, op. cit. For a recent typology of different platforms and a survey of platforms development worldwide see Evans, P., & Gawer, A. (2016). The Rise of the Platform Enterprise. A Global Survey, op. cit.

[107] See: Li, J. (2015). Is online media a two-sided market? Computer Law & Security Review: The International Journal of Technology Law and Practice, 31(1), 99-111; Luchetta, G. (2014). Is the Google Platform a Two-Sided Market? Journal of Competition Law and Economics, 10(1), 185-207.

[108] Lougher, G., & Kalmanowicz, S. (2016). EU Competition Law in the Sharing Economy. Journal of European Competition Law & Practice, 7(2), 87-102.

[109] Codagnone, C. and Martens, B. (2016). Scoping the Sharing Economy: Origins, Definitions, Impact and Regulatory Issues. Institute for Prospective Technological Studies Digital Economy Working Paper 2016/01 JRC100369, p. 8.

[110] Gawer, A., & Cusumano, M. (2002). Platform Leadership. Boston, MA: Harvard Business School Press.

[111] Caillaud, B., & Jullien, B. (2003). Chicken & egg: Competition among intermediation service providers. The RAND Journal of Economics, 34(2), 309-328.

[112] Rochet, J.-C., & Tirole, J. (2003). Platform Competition in Two-sided Markets. Journal of the European Economic Association, 1(4), 990-1029; Rochet, J.-C., & Tirole, J. (2006). Two-sided markets: a progress report. Rand Journal of Economics, 37(3), 645-667.

[113] Evans, D. (2003a). The Antitrust Economics of Multi-Sided Platform Markets. Yale Journal on Regulation, 20(2), 325-381. Evans, D. (2003b). Some Empirical Aspects of Multi-sided Platform Industries. Review of Network Economics, 2(3), 2194-5993.

[114] Evans, D. (2008a). Competition and Regulatory Policy for Multi-Sided Platforms with Applications to the Web Economy. Concurrences, 2; Evans, D. (2008b). The Economics of the Online Advertising Industry. Review of Network Economics, 7(3), 351-391. doi: 10.2202/1446-9022.1154; Evans, D. (2009). The Online Advertising Industry: Economics, Evolution, and Privacy. Journal of Economic Perspectives, 23(3), 37-60; Evans, D. (2011). Platforms Economics: Essays on Multi-Sided Businesses: Competition Policy International.

[115] Parker, G., & Van Alstyne, M. (2000). Internetwork externalities and free information goods. Paper presented at the Proceedings of the 2nd ACM conference on Electronic commerce, Minneapolis, Minnesota, USA; Parker, G. G., & Alstyne, M. W. V. (2005). Two-Sided Network Effects: A Theory of Information Product Design. Management Science, 51(10), 1494-1504

[116] Rysman, M. (2009). The Economics of Two-Sided Markets. [10.1257/jep.23.3.125]. Journal of Economic Perspectives, 23(3), 125-143.

[117] Hagiu, A., & Wright, J. (2015a). Marketplace or Reseller? Management Science, 61(1), 184-203. doi: 10.1287/mnsc.2014.2042; Hagiu, A., & Wright, J. (2015b). Multi-sided platforms. International Journal of Industrial Organization.

[118] Rochet, J.-C., & Tirole, J. (2006). Two-sided markets: a progress report, op. cit., pp.664-665.

[119] See: Armstrong, M. (2006). Competition in two-sided markets. Rand Journal of Economics, 37(3), 668-691; Evans, D. (2003a). The Antitrust Economics of Multi-Sided Platform Markets, op. cit.; Evans, D., & Noel, M. (2005). Defining Antitrust Markets When Firms Operate Two-Sided Platforms. Columbia Business Law Review, 3, 667–702; Evans, D., & Schmalensee, R. (2007). The Industrial Organization of Markets with Two-Sided Platforms Competition Policy International, 3(1), 151-179; Wright, J. (2004). One-sided Logic in Two-sided Markets. Review of Network Economics, 3(1), 44-64.

[120] Rysman, M. (2009). The Economics of Two-Sided Markets, op.cit.

[121] See: Li, J. (2015). Is online media a two-sided market? Computer Law & Security Review: The International Journal of Technology Law and Practice, 31(1), 99-111.

[122] Filistrucchi, L., Geradin, D., & Van Damme, E. (2013). Identifying Two-Sided Markets. World Competition: Law & Economics Review, 36(1), 33-60.

[123] Filistrucchi, L., Geradin, D., van Damme, E., & Affeldt, P. (2014). Market Definition in Two-Sided Markets: Theory and Practices. Journal of Competition Law and Economics, 10(2), 293-339.

[124] Autor, D. (2015). Why Are There Still So Many Jobs? Op. cit.

[125] Acemoglu, D. & Restrepo, P. (2018). The Race between Man and Machine, op. cit.

[126] Frey, C., & Osborne, M. (2013). The Future of Employment: How Susceptible Are Jobs to Computerisation? Oxford Martin School Working Paper. Oxford. Later published as Frey, C., & Osborne, M. (2017). The future of employment: How susceptible are jobs to computerisation? Technological Forecasting and Social Change, 114, 254-280.

[127] Bowles, J. (2014). The computerisation of European jobs. Bruegel Centre.

[128] Arntz, M., T. Gregory and U. Zierahn (2016). The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis. OECD Social, Employment and Migration Working Papers, No. 189, OECD Publishing, Paris.

[129] Bessen, J. (2015). Toil and Technology. Finance & Development, 52(1), 16-19

[130] Bessen, J. (2016) How Computer Automation Affects Occupations: Technology, Jobs, and Skills (October 3, 2016). Boston Univ. School of Law, Law and Economics

Research Paper No. 15-49. Available at SSRN: https://ssrn.com/abstract=2690435

131 Bessen, J. (2018). Automation and Jobs: When Technology Boosts Employment. Boston Univ. School of Law, Law and Economics Research Paper No. 17-09. Available at SSRN: https://ssrn.com/abstract=2935003

132 Acemoglu, D. and Restrepo, P. (2017). Robots and Jobs: Evidence from US Labor Markets. NBER Working Paper, 23285.

133 Graetz, G., & Michaels, G. (2017). Is modern technology responsible for jobless recoveries? Op. cit.

134 Goos, M., Manning, A. and Salomons, A. (2014). Explaining job polarization: Routine-biased technological change and offshoring", American Economic Review, 104(8), 2509–2526.

135 Dauth, W., S. Findeisen, J. Südekum, and N. Woessner (2017). German robots-the impact of industrial robots on workers. CEPR Discussion Paper No. DP12306.

136 Chiacchio, F., Petropoulos, G., & Pichler, D. (2018). The impact of industrial robots on EU employment and wages: A local labour market approach. Bruegel Working Paper Issue 02/18.

137 Goldin, I. (2015), "The Future of Work", Huffington Post, available at: http://www.huffingtonpost.com/ian-goldin/the-future-of-work_1_b_6802184.html

138 Duchatelet, R. (2016), "Re-inventing social security", Basic Income News, available at: http://basicincome.org/news/2016/11/re-inventing-social-security/

139 Zhang, Y. (2017), Would Bill Gates's proposed robot tax help workers?, Tax Policy Center, Retrieved from http://www.taxpolicycenter.org/taxvox/would-bill-gatess-proposed-robot-tax-help-workers

140 Summers, L. (2017), Robots are wealth creators and taxing them is illogical, Financial Times, 5 March

141 Meyer, H. (2017), "No Need For Basic Income: Five Policies To Deal With The Threat Of Technological Unemployment", available at: https://www.socialeurope.eu/no-need-basic-income-five-policies-deal-threat-technological-unemployment

142 Schiller, R. (2017). Taxing Robots? Social Europe (https://www.socialeurope.eu/taxing-the-robots ).

143 Soete, L. & Kamp, K. (1996). The 'bit tax': the case for further research, op. cit.

144 See for instance Washington Center for Equitable Growth, (2018) Assessing the economic effects of the Tax Cuts and Jobs Act (https://equitablegrowth.org/assessing-the-economic-effects-of-the-tax-cuts-and-jobs-act/ ).

145 See European Commission, (2018). Impact Assessment. Accompanying the document Proposal for a Council Directive laying down rules relating to the corporate taxation of a significant digital presence and Proposal for a Council Directive on the common system of a digital services tax on revenues resulting from the provision of certain digital services. Brussels, SWD(2018) 81 final/2 (https://ec.europa.eu/taxation_customs/sites/taxation/files/fair_taxation_digital_economy_ia_21032018.pdf )

146 Bauer, M. (2018). Five Questions about the Digital Services Tax to Pierre Moscovici. ECIPE Occasional Paper 04/2018, European Centre for International Political Economy, ECIPE (http://ecipe.org//app/uploads/2018/06/Five-Questions-about-the-Digital-Services-Tax-to-Pierre-Moscovici.pdf ).

147 Copenhagen Economics, (2018). The Proposed Eu Digital Services Tax: Effects on welfare, growth and revenues (https://www.copenhageneconomics.com/dyn/resources/Publication/publicationPDF/7/457/1537162175/copenhagen-economics-study-on-the-eu-dst-proposal-13-september.pdf ).

148 Coase asked a very simple question: What is a firm? If we know from economic textbook that the market is good in allocating resources among competing objectives, why do we need a firm? This is the "make or buy" Coasian dilemma. The answer, or at least Coase's answer, was transaction costs. See Coase, R. (1937). The Nature of the Firm. Economica, 4(16), pp. 386-405.

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