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Industrial Policy of Digitization in Europe: The Fragile Promise of Productivity and Jobs

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Abstract

Deepening and accelerating digitalisation is an essential part of industrial policy in Europe. The focus on digital infrastructures and supply-side politics for digital innovation and deepening on company-level strive to accelerate competitiveness. Increasing productivity as well as high-skilled employment are core targets of the European strategy, which is focused on Small and Medium-sized Enterprises (SME) as the structurally relevant actor group for large-scale implementation of digital technologies. However, the measurable productivity effects (labour and factor productivity) have been low so far, although there is a high automation potential in digitisation. Positive employment effects of digitalisation also rely on critical socio-economic premises. SME as "game changer" group are chronically unready for digitalisation technologies. In sum, digitalisation as industrial strategy for transformation and modernisation requires a comprehensive capture of asymmetric effects on productivity and employment on company and sector level.

1 Introduction

Digitisation and competitiveness have been an inseparable pair of terms in European politics for almost two decades. At the latest since the introduction of the European Commission's Digital Economy and Society Index (DESI)[1] in 2014, digitisation has been a measure of the modernisation of European economies. The DESI measures the digital progress of the member states, creates country profiles and recommendations for priority digitisation measures. With the Digital Strategy, the EU Commission has declared the decade of the 2020s as the "Digital Decade" and is making €127 billion available for investment in national build-up and resilience plans. Member States have allocated an average of 26% of their Recovery and Resilience Facility (RRF) funds to digital transformation, above the mandatory threshold of 20%.

Digitisation is part of the European Industrial Strategy of 2020, the main areas of which are digital sovereignty, cybersecurity, key technologies such as artificial intelligence and quantum computing, cloud computing and infrastructure (EU COM 2020). A designated target group are small and medium-sized enterprises (SMEs), which on the one hand have a lower average level of digital maturity than large companies, but on the other hand represent the central units for implementation due to their economic relevance.

Understanding digitalisation as part of industrial policy requires a definition of digitalisation and a functional definition of industry, which is expanded to include, for example, industry-related services. In the narrow view, European industry in 2018 stood for a gross value added of 3.5 trillion Euros, which corresponds to approximately 22 % of EU value added. Over 83 percent of EU exports are industrial goods, and 32 million jobs subject to social security contributions are located there (Eurostat 2020).

In addition to increasing competitiveness, digitisation is also expected to boost employment in Europe (von der Leyen 2022). The validity of the positive employment effect of digitisation processes is based on a series of model-theoretical assumptions, which are discussed in this paper. The effect on competitiveness as a result of company digitisation processes must also be placed in the debate about the relatively low productivity development in Europe, which has been going on for some time. A third aspect, which is, however, only briefly touched

[1] See: https://digital-strategy.ec.europa.eu/de/policies/desi

upon, is the question of the optimal digital maturity level of SMEs and thus of the objective measurability of digital maturity levels in the heterogeneous structure of European industry.

2 Digitisation as part of the European industrial policy

The EU's industrial policy has a long history. The creation of the common internal market was the framework condition for more far-reaching strategies, such as the Lisbon Strategy of 2000, which was to make Europe the "most competitive and dynamic knowledge-based economy in the world" by 2010. The challenges at the time were high unemployment (and the associated problems) and a modernisation inertia with regard to the digitalisation of companies.

The EU's industrial policy goals are primarily aimed at strengthening the competitiveness of companies in the EU. The "location policy" of the EU and its member states focuses on supply-side measures to make it easier for companies, especially SMEs, to modernise.

Industrial policy measures include lowering corporate taxes, capping social security contributions, making labour markets more flexible, mobilising skilled labour, expanding infrastructure, reducing bureaucracy and others. Modernisation ideas are closely linked to digitalisation, especially the "game change technology" artificial intelligence under the buzzword "Industry 4.0", as well as mobility of the future, low-emission industry and bioeconomy (BMWK 2019). The declared goal - in addition to strengthening competitiveness - is technology sovereignty, for which the "Important Project of Common European Interest" (IPCEI) instrument was further developed in order to identify strategic European supply chains on the one hand and to support the expansion of key technologies on the other. IPCEIs are part of European competition policy in order to be able to provide state support for projects of common European interest without coming up against the limits of state aid law. For this, IPCEIs must fulfil a number of criteria, such as the participation of several member states or the co-financing of the funding by the participating companies or institutions. Previous IPCEIs have included funding for energy-efficient computer chips, smart sensor development or efficiency improvements in battery cells. The most recent project under the umbrella of an IPCEI is the "Next Generation Cloud" to build a cloud edge infrastructure to strengthen European data sovereignty and the production of "green" hydrogen for the steel and chemical industries.

The central conceptual canon of European industrial policy consists of competitiveness and sovereignty. Both are relational concepts in distinction to other economic areas. Despite the

historical self-image of being the "home" of industry, whose economic core was the increase of material and temporal welfare as a result of high productivity increases, the concept of productivity does not play an explicit role in the EU's industrialisation strategy – the only exception is the context of digitalisation. New business models, new competences, new scalability in the digitalised economy are identified as necessary for strengthening the economy. This is because Europe is apparently lagging behind in digitalisation, in data generation, use and evaluation as well as in infrastructure (5G and cloud) (EU COM 2020: 4).

Digitisation is a pillar of the "Next Generation EU" programme, which is in the process of being created as a Corona fund financed by joint debt of €750 billion. While not explicitly designed as an investment fund for a European industrial policy, the fund nevertheless essentially fulfils such functions by targeting the key areas of digitisation and sustainable energy infrastructure. It is mainly an instrument for structural change. Obviously increasing carbon neutrality is core to this change, other pillars are an increasing resilience of supply chains, reaping (process) efficiencies and (product) optimisations by digitalisation and increasing high-skilled employment. Digitalisation is part of productivity-enhancing technologies, which are supposed to transform the old “home” of industry into a new one. In the next chapter, I first want to recapitulate the debate of sluggish productivity growth before I discuss the associated promise of rising, high-skilled employment.

3 Supply-sided productivity promise of digitalisation

The EU digital strategy measures are intended to activate the productivity potential of digitalisation. The US or China serve as an economic role model when it comes to digital readiness, infrastructure and development speed. Various correlations of automation technologies, positive employment effects and skill upgrading (Xiaozhen et al. 2022) seem to underscore this approach.

Historically, the measurable productivity effects on labour and factor productivity have been small so far, although there is obviously a high potential for automation in digitisation, which increases labour productivity through capital deepening. Digitisation has been in full swing since the advent of personal computers, in production even earlier. Nevertheless, the productivity effects of digitalisation are either hardly measurable and/or exist only to a very limited extent.

The general trend of slowing productivity growth in OECD countries has led to an intense debate about the causes and prospects of productivity development. Even after decade of

discussion, analyses and forecasts remain controversial, but can be divided into two main strands. First, a more statistical-methodological strand that revolves around problems of measuring productivity. Do the typical productivity measures such as gross domestic product per hour worked capture the actual development and what is the role of quality and price determination as well as the role of information and communication technology and digitalisation? Second, there is a strand of discussion that focuses more on the temporal dimension and interpretation of the current flattening. The spectrum of the debate is broad: Is it a cyclical dip, as has already been observed in the past? Or is it a long-term trend break that can only be overcome through increased efforts, for example in the area of digitalisation (cf. Markert et al. 2017: 1-12)?

Measurement errors concern, among other things, the definition of the measurement and recording of productivity, which are exacerbated in particular by the intangible properties of the digital. Growth is fundamentally underestimated in this respect, although the effects due to measurement errors of "the digital" are not large enough to explain the observable decline in productivity growth. The Solow productivity paradox cannot be explained by measurement errors alone (Hartwig/Krämer 2017).

The extent to which structural "headwinds" (Gordon 2016) inhibit the productivity effects of digitalisation is also part of the debate and its clarification would be essential for European industrial policy. The relatively weak innovative power of digitalisation would be exacerbated in terms of prolonged secular stagnation by the consequences of an increasingly unequal distribution of income and wealth, the weaknesses of the education system, rising public debt and an ageing population (ibid.; and for a discussion of the thesis: Herzog-Stein et al. 2017).

A different interpretation of the actual and potential productive forces of digitalisation leads to a different picture and in principle guides digitalisation strategies in Europe (at both EU and member state level). Prospective forces of innovation, such as in nano-technology, bio-chemistry and genetics, artificial intelligence, greater international competition and faster communication of research results and their translation into new goods, and more generally the greater number of global researchers, will lead to explosive growth in productivity (Mokyr 2014). This techno-optimistic view is widespread and underpins the position of the diffusion of new technologies and investment in knowledge-based capital as drivers of future productivity growth.

Obviously, the EU’s digital industrial policy is based on the optimistic scenario, which is rational just as well as it is limited. The (supply-side) focus on framework conditions for

digitalisation contrasts with the (demand-side) preconditions for its productive unfolding, which inhibits the danger of an asymmetry of effects especially with regard to labour market effects.

4 Premised employment effects

The discussion about the quantitative impact of digital technology implementation on employment has also been going on for several years now. Quite a few notable studies have come to the conclusion that the digitisation of the labour environment will result in massive upheavals in the form of job losses. Professions in transport, logistics, manufacturing, and services are among the most endangered. Low- and middle-income groups will be at the centre of the job-cutting process, and this is why technologically driven unemployment further catalysed by digitisation would accelerate existing polarisation. In addition to manual routine activities, machine learning and mobile (lightweight) robotics could perform cognitive tasks without firm specifications and thus bring about upheavals in the middle and upper strata of the workforce (Frey/Osborne 2013; 2017; Muro et al. 2019).[2]

There is a consensus that digitisation can potentially lead to the substitution of labour. The only question is how great this potential is and what counterforces there will be if they are necessary. The difference between a direct disruption in the labour market and moderating effects is usually made by a "net calculation" across society (Arntz et al. 2017; Arntz et al. 2018; Dauth et al. 2017; Fuchs et al. 2018). Jobs or activities eliminated by digitisation are contrasted with new jobs in other areas. Growing productivity propelled by digitisation brings macroeconomic competitive advantages, added value, and ultimately employment effects (McKinsey Global Institute 2018; World Economic Forum 2018).

The potential for substitution is accompanied by positive quantitative employment expectations. The compression of work is connected with a growth in productivity. Digitisation requires investments to be made, and these investments can mean either more or less employment. In an optimistic scenario, the implemented digital technology will lead to a

[2] The binary opposition between routine and non-routine tasks is, however, very limited and encourages a premature definition of digital technologies as instruments of human replacement (Pfeiffer/Suphan 2015; Autor 2015). It is evident – and an outspoken goal – that the existing processes and organisation of work are becoming more efficient: driverless transport systems, man-robot-collaboration (cobots), smart glasses, 3D-print and additive manufacturing, digital assistance systems, enterprise resource planning, digital twins, and other innovations are increasingly becoming part of the company-level and industry-wide division of labour. Such systems have far-ranging effects on individual jobs and are accompanied, in many cases, by a concentration of workflow and workload (Dispan/Schwarz-Kocher 2018). In addition to the qualitative aspects of these alterations in labour, this development also leads to possible quantitative changes.

technological upgrade and change the capital structure in a business. Rising overall employment is thus a consequence of the growing demand for a concrete type of capital. The increase in production demand in industries providing the inputs for this type of capital leads to growing employment in the economy as a whole.

Furthermore, investments in digitisation technology alter the cost structure and thus also the relative competitiveness of companies. Businesses that cut their costs thanks to digitisation can lower their prices and increase the demand for their products and services correspondingly, provided there is constant demand from other sectors of the economy (Arntz et al. 2018). Consequently, the output of the investing businesses increases and produces new income in the form of wages, profits, and capital income. An important aspect in this scenario is the competitiveness effect as well as the division of earnings into capital- and labour-related income. Rising productivity reduces the production costs for automated activities, which can lead to a growth in profits or an increased demand for work in non-automated activities. Corresponding simulations have shown that this is often followed by long-term surges in the overall demand for the workforce in the economy (Fuchs et al. 2018).

Looking at these and similar considerations more closely, it becomes apparent that they strongly rely on spill-over effects from one sector to another. However, they are much more complex than is commonly assumed. Many problems emerge; if capital productivity increases in relation to work, technological innovations are generally labour-saving, meaning that it is rather unlikely that growing productivity would result in increased average wages. If labour is replaced by technology faster than new labour is created, then technology replaces work; and no increase in labour demand in other sectors is necessarily created. Ultimately, digitisation decisions made by a business will always be the result of a calculation of relative factor prices, i.e., relative prices for all necessary production factors. It is therefore not unlikely that digitisation will be accompanied by sinking average wages, because the substitution effect leads to a decreased labour demand (Acemoglu/Restrepo 2018). The outcome will be a growing inequality first on the labour market and then in the whole economy (Korinek/Stiglitz 2017). This context also highlights the need for a regulatory framework or a redistribution of profits from innovations, because otherwise the overall outcome from technology-driven innovation can be negative for society as a whole when compared with the situation before the innovation (Acemoglu 2019).

Even if higher wages become a reality as a result of digitisation in an industry or the economy as such, this does not mean that potential purchasing power will materialise in new

purchasing activities in either the same or other business areas. A lot depends on other factors, such as the way digitisation creates a new structure of economic demand (for instance, via new purchasing patterns), how high or low earners profit from it, and what savings rates currently shape the economy. Until now it has been empirically observed that higher qualified labour profits from digitisation and human activity are mostly complemented by it. There is flexible demand for the corresponding products and services provided by the workforce; at the same time, however, there is inflexible labour supply in these areas (i.e., a shortage of skilled workers). Activities performed by workers with lower qualification profiles paint a different picture. The demand for manual activities is relatively inflexible as far as their price is concerned; if the price of manual activities drops due to digitisation, the demand for them does not rise correspondingly.[3]

This (Keynesian) scenario could be labelled "Polarisation 4.0" (cf. Autor et al. 2017; Autor/Salomons 2017) as is pretty much missing in the digital industrial policy considerations of the EU Commission. Instead an automatic interconnection between digitisation, boosts to productivity, and a growing demand for labour is implied by the EU's digital-industrial strategy.

5 Structural unreadiness of SME[4]

The focus of digitalisation on SMEs is based on the analysis that the level of digital maturity in the company size unit is lower than in large companies (cf. for Germany: Demary & Goecke 2021). Only around one fifth of all SMEs in Germany have already digitalised their processes and production (Plattform Lernende Systeme[5]). The reasons for these developments are manifold, but one important reason is that financial and human resources are more limited in SMEs than in large companies. Accordingly, SMEs also account for only 12 percent of all companies' expenditure on research and development (cf. Wangermann 2020). In addition, a lack of skilled workers with the appropriate expertise poses a challenge. This also applies above all to IT specialists, who are rare on the labour market and more often work in large companies due to higher salaries. (cf. Lundborg & Märkel 2019). Furthermore, a lack of data,

[3] See Albrecht & Kellermann (2020) for an extensive discussion of the scenarios.

[4] Credits to Rolf Feichtenbeiner, DFKI Berlin

[5] https://www.plattform-lernende-systeme.de/startseite.html

caused by a smaller data potential due to the smaller size of the company, can represent a structural hurdle for further digitisation processes.

Nevertheless, many SMEs have recognised the increasing importance of digitalisation and AI.[6] Digitalisation can develop potential throughout the entire value chain, but especially in optimising the supply chain and increasing process efficiency (cf. Lundborg & Märkel 2019). A plethora of national and European funding programmes are attempting to introduce SMEs to digitalisation and compensate for the limited preconditions by offering financial and non-material funding. Nevertheless, the target group is not only extremely heterogeneous, but also relatively tightly staffed that even targeted offers often cannot be accepted. The question is therefore whether and how digitisation can effectively reach this target group as part of industrial policy efforts. Funding alone will not do the trick.

6 Conclusion

The focus of the European digitisation strategy on the corresponding infrastructure is a rational approach to modernising the European economies. Nevertheless, against the background of the unclear preconditions for the development of broad productive forces through digitisation, an automatism for rising productivity and employment cannot be assumed.

The rapid development of core digital technologies, with AI and machine learning at the current technological frontier, requires a *continuous and holistic* approach to labour and the socio-economic dimension of technology (Kellermann & Obermauer 2020). It is important to continuously and carefully observe all technological developments in society. An open and independent technology impact assessment which is focused on specific uses as well as social impact thus remains a fundamental prerequisite for the tangible evaluation of the potential of technology, including its social impact.

The EU's approach would need to be completed by an observatory of socio-economic effects of digitalisation. Corresponding regulations need to be created with which the use of new technologies can be coordinated with social norms and needs, both at the individual workplace and with regard to the role of work in the labour society and the economy as a whole.

[6] https://www.ki-wissens-und-weiterbildungszentrum.de

Bibliography

Albrecht, T. / Kellermann, C. (2020): *Artificial Intelligence and the Future of the Digital Work-Oriented Society. An Outline for a Holistic Technology Impact Assessement*. Friedrich Ebert Foundation Publishing. Cited from: (http://library.fes.de/pdf-files/bueros/bratislava/16955.pdf)

Acemoglu, D. (2019): *Elizabeth Warren's Bold Ideas Don't Go Far Enough.* Project Syndicate. Cited from: (https://www.project-syndicate.org/commentary/good-jobs-agenda-us-by-daron-acemoglu-2019-12).

Acemoglu, D. / Restrepo, P. (2018). *Artificial Intelligence, Automation and Work.* NBER Working Paper No. 24196. Cited from: (https://www.nber.org/papers/w24196.pdf).

Arntz, M. / Gregory, T. / Zierahn, U. (2017). Revisiting the Risk of Automation. In: *Economics Letters*, No. 159, pp. 157–160.

Arntz, M. / Gregory, T. / Zierahn, U. (2018). *Digitalisierung und die Zukunft der Arbeit: Makroökonomische Auswirkungen auf Beschäftigung, Arbeitslosigkeit und Löhne von morgen*. (Digitisation and the Future of Labour: Macroeconomic Impacts on Employment, Unemployment, and the Wages of Tomorrow). Bundesministerium für Forschung und Entwicklung (BMBF), Mannheim. Cited from: (http://ftp.zew.de/pub/zew-docs/gutachten/DigitalisierungundZukunftderArbeit2018.pdf).

Autor, D. (2015). Why Are There Still So Many Jobs? The History and Future of Workplace Automation. In: *Journal of Economic Perspectives*, No. 29(3), pp. 3–30. Cited from: (https://economics.mit.edu/files/11563).

Autor, D. / Dorn, D. / Katz L.F. / Patterson, C. / Van Reenen, J. (2017). Concentrating on the Fall of the Labor Share. In: *American Economic Review Papers & Proceedings*, No. 107(5). pp. 180–185. Cited from: (https://economics.mit.edu/files/12544).

Autor, D. / Salomons, A. (2017). Robocalypse Now – Does Productivity Growth Threaten Employment? In: *ECB Forum on Central Banking – Investment and Growth in Advanced Economies – Conference Proceedings*. Frankfurt am Main: European Central Bank, pp. 119–128. Cited from: (https://www.ecb.europa.eu/pub/pdf/other/ecb.ecbforumcentralbanking2017.en.pdf).

Bessen, J. (2018). AI and Jobs: The Role of Demand. In: *NBER Working Paper Series*, No. 24235. Cited from: (https://www.nber.org/papers/w24235.pdf).

BMWK (2019): Industrielle Wettbewerbsfähigkeit nachhaltig stärken. Die Industriestrategie 2030. https://www.bmwk.de/Redaktion/DE/Dossier/Industriestrategie%202030/die-industriestrategie-2030.html (abgerufen am 20.09.22)

Dauth, W. / Findeisen, S. / Südekum, J. /Wößner, N. (2017). German Robots – The Impact of Industrial Robots on Workers. In: *IAB-Discussion Paper*, 30/2017. Cited from: (http://doku.iab.de/discussionpapers/2017/dp3017.pdf).

Demary, V. / Goecke, H. (2021). Digitalisierung der Branchen in Deutschland – eine empirische Erhebung. *Wirtschaftsdienst – Zeitschrift für Wirtschaftspolitik*. DOI: 10.1007/s10273-021-2871-z

Dispan, J. / Schwarz-Kocher, M. (2018). Digitalisierung im Maschinenbau. Entwicklungstrends, Herausforderungen, Beschäftigungswirkungen, Gestaltungsfelder im Maschinen- und Anlagenbau. (Digitisation in Machine Engineering: Development Trends, Challenges, Employment Impact, and Design Fields in Machine and Equipment Construction). In: *Working Paper Forschungsförderung,* No. 094. Cited from: (https://www.boeckler.de/pdf/p_fofoe_WP_094_2018.pdf).

Eurostat (2020): Small and medium-sized enterprises: an overview, https://ec.europa.eu/eurostat/de/web/products-eurostat-news/-/ddn-20200514-1, 21.09.22

EU COM (2020): Ene neue Industriestrategie für Europa. https://ec.europa.eu/info/sites/default/files/communication-eu-industrial-strategy-march-2020_de.pdf (abgerufen am 20.09.22)

Frey, C. B. / Osborne, M. A. (2013). *The Future of Employment: How Susceptible are Jobs to Computerisation?* Oxford Martin School (OMS) Working Paper. University of Oxford. Cited from: (https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf).

Frey, C. B. / Osborne, M. A. (2017). The Future of Employment: How Susceptible are Jobs to Computerisation? In: *Technological Forecasting & Social Change.* No. 114, pp. 254–280.

Fuchs et al. (2019): Zuwanderung und Digitalisierung. Wie viel Migration aus Drittstaaten benötigt der deutsche Arbeitsmarkt künftig? (Immigration and Digitisation. How Much Migration from Third Countries will the German Labour Market Need in the Future?).

Bertelsmann Stiftung. Cited from: (https://www.bertelsmann-stiftung.de/fileadmin/files/Projekte/Migration_fair_gestalten/IB_Studie_Zuwanderung_und_Digitalisierung_2019.pdf).

Gordon, R. J. (2016). The Rise and Fall of American Growth – The U.S. Standard of Living since the Civil War. Princeton University Press, Princeton.

Hartwig, J./ Krämer, H. (2017). Zwischen Hoffnungsträger und Spielverderber: der Beitrag von Dienstleistungen zum Produktivitätswachstum, in: Wirtschaftsdienst, 97. Jahrgang, Heft 2, S. 99-102.

Herzog-Stein, A., Friedrich, B., Sesselmeier, W., & Stein, U. (2017). *Wachstum und Produktivität im Gegenwind: Eine Analyse der Argumente Robert Gordons im Spiegel der deutschen Produktivitätsschwäche* (No. 124). IMK Report.

Kellermann, C. / Obermauer, R. (2020). Von der Würde der Arbeit in digitaler und klimaneutraler Zukunft. (On the Dignity of Work in a Digital and Climate-neutral Future). spw 238

Korinek, A. / Stiglitz, J. E. (2017). Artificial Intelligence and Its Implications for Income Distribution and Unemployment. In: *National Bureau of Economic Research*. Cited from: (https://www.nber.org/papers/w24174.pdf).

McKinsey Global Institute [MGI] (2018). *Notes from the AI Frontier: Modeling the Impact of AI on the World Economy.* Cited from: (https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy).

Markert, C. / Neumann, H. / Amlinger, M. (2017). Geschichte und Zukunft der Produktivität. Eine oder Halbzeit eines großen Spiels. IGZA Arbeitspapier 3, Cited from: (https://igza.org/wp-content/uploads/2017/12/IGZA_Arbeitspapier_3.pdf)

Mokyr, J. (2014). *Secular stagnation? Not in your life.* Secular stagnation: Facts, causes and cures, 83.

Muro, M. / Maxim, R. / Whiton, J. (2019). Automation and Artificial Intelligence: How Machines are Affecting People and Places. Metropolitical Policy Program. Cited from: (https://www.brookings.edu/wp-

content/uploads/2019/01/2019.01_BrookingsMetro_Automation-AI_Report_Muro-Maxim-Whiton-FINAL-version.pdf).

Lundborg, M / Märkel, C. (20199. Künstliche Intelligenz im Mittelstand. Cited from: (https://www.mittelstand-digital.de/MD/Redaktion/DE/Publikationen/kuenstliche-intelligenz-im-mittelstand.pdf?__blob=publicationFile&v=5).

Pfeiffer, S., / Suphan, A. (2015). *Der AV-Index. Lebendiges Arbeitsvermögen und Erfahrung als Ressourcen auf dem Weg zu Industrie 4.0*. Working Paper 2015 No. 1 (final version of a draft originally published on 13 April 2015). Cited from: (https://www.sabine-pfeiffer.de/files/downloads/2015-Pfeiffer-Suphan-final.pdf).

Von der Leyen, U. (2022): State of the Union 2022. https://ec.europa.eu/commission/presscorner/detail/de/SPEECH_22_5493

Wangermann, T. (2020). KI in KMU : Rahmenbedingungen für den Transfer von KI-Anwendungen in kleine und mittlere Unternehmen. Analysen und Argumente / Konrad-Adenauer-Stiftung e.V. . St. Augustin, Nr. 381

Webb, M. (2019). *The Impact of Artificial Intelligence on the Labour Market.* Stanford University Working Paper.

World Economic Forum (2018). *The Future of Jobs Report* (2018). Cited from: (http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf).

Xiaozhen Qin, Weipan Xu, Haohui ‘Caron’ Chen, Jiawei Zhong, Yifei Sun & Xun Li (2022) Automation, firm employment and skill upgrading: firm-level evidence from China, Industry and Innovation, DOI: 10.1080/13662716.2022.2122411