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Opinion

Big IFs in Productivity-Enhancing Industry 4.0

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Abstract: With the dawn of Industry 4.0, its productivity-boosting impact appears to be comfortably ensconced both in the media and in the scientific community. Still, our paper is to portend a rather dismal prognosis by outlining three big Inertia Forces (IFs) hindering the power of Industry 4.0 in reviving productivity growth in a more spectacular way. After applying a complexity view to the development of Industry 4.0 in deciphering the major IFs, the paper briefly exemplifies them by building on the case of Hungary, and it then draws some lessons for theorists and economic policy practitioners in the interest of a value-congruent development of Industry 4.0.

Keywords: Industry 4.0; inertia; complexity; governance; trade-offs; uncertainty; Hungary

1. Introduction

After almost a quarter-millennium, mankind has to navigate through yet another industrial revolution, often referred to as Industry 4.0.[1] This phenomenon has been garnering attention from the side of theorists and economic practitioners alike. Nevertheless, studies have merely been addressing particular or quite specific issues rather than discussing and evaluating the complex socioeconomic repercussions of it. In addition, despite the fact that the new industrial revolution is an open-ended and quite complex set of processes, authoritative researchers, scholars, and pundits have a predilection for envisioning shining lights associated with the development of Industry 4.0, such as a powerful rehabilitation of productivity growth.[2]

The main purpose of this study is to show that recent socioeconomic nexus seem to challenge the positive expectation about the spectacular productivity-enhancing impact of Industry 4.0. Within the current conditions of the socioeconomic innovation ecosystem in the developed world, with the evolving and diffusing Industry 4.0 and digital economy, serious trade-offs and unintended consequences are arising, leading to increasing uncertainty over the sustainability of such development. In other words, one of the most voiced shining lights of Industry 4.0, the promise of resurgent productivity growth, can easily become nothing more than a 3D-printed pipe dream.

[1] The raison d'être of Industry 4.0 is the creation of self-optimising cyberphysical systems by building upon various technologies, starting from the wide application of Information and Communication Technologies (ICTs), sensors, robotics, through to additive production, internet-based continuous communication and interaction, simulation and virtual modelling, cloud-based services, augmented reality, data mining, and artificial intelligence, as well as machine learning.

[2] Despite the lack of convincing empirical backing (Baldassarre et al. 2017), improved productivity via Industry 4.0-related technologies (e.g., robotics, see Graetz and Michaels (2018) piece on its impact) and nontechnological solutions is widely expected in the literature. See: Aichholzer et al. (2015); BCG (2015); Dalenogare et al. (2018); Vaidya et al. (2018); and World Economic Forum (2018). In the case of small and medium-sized enterprises, see Ghafoorpoor Yazdi et al. (2018) or Schröder (2016) on Germany or Nagy et al. (2018) on the Hungarian case. In a recent comprehensive work by Petrillo et al. (2018), they declared that Industry 4.0 will concur to create new wealth and it has now become strategic to pursue ever-more digitalization of manufacturing, while developing national or regional investment plans to encourage companies to invest in the 4.0 revolution is of key importance as well. Another calculation, addressing the issue of whether productivity growth will return in the digital era, envisions more than 50% rate of diffusion in 10 years (Saniee et al. 2017).

As for our methodological approach, in the spirit of René Descartes, an outstanding philosopher of a century that paved the way for the first industrial revolution and who once emphasised that one way to demonstrate is analysis, the other is synthesis, we built a verbal model by partly synthesising the messages of quantitative- and qualitative-focused economic analyses together with the relevant messages of complexity science. In doing so, we grounded a new narrative with a broadened research canvas over the potential productivity impact of the current Industry 4.0 revolution. As for the structure, the paper first applies a complexity view to the development of Industry 4.0 in deciphering the major IFs, then it briefly exemplifies them by building on the case of Hungary, and finally, it draws some important lessons for theorists and economic policy practitioners in the interest of a value-congruent development of Industry 4.0.

2. Self-Organised Criticality in the Socioeconomic Innovation Ecosystem

A relatively new stream of economic literature focuses on the issue of secular stagnation, meaning the long-lasting withering productivity, thus that of innovation performance in the advanced world (Teulings and Baldwin 2014; Bergeaud et al. 2017). Secular stagnation is associated with escalating uncertainties—unknown risks—leading to increasing instability of the socioeconomic system. There is a growing body of evidence that increases in uncertainty are mainly associated with protracted negative impetus on economic activity (Baker et al. 2013; Bachmann et al. 2013), so secular stagnation is associated with increasing uncertainties.

With a more systemic view, borrowed from complexity science, we can elaborate on a more nuanced view on secular stagnation. Systemic thinking gained traction in a more vigorous way in the 20th century inter alia in organismic biology, Gestalt psychology, chemical kinetics, ecology, and even in economics. Since natural and social sciences deal with living systems alike, the analysis of the relationships among the parts started to garner much more attention with time, especially if a structural change is to be better understood (like secular stagnation). System thinking gave rise to the discipline of complexity science in the past several decades. Briefly and succinctly, under the pretext of complexity science, a socioeconomic system is thus regarded as an open, dynamic, and adaptive system embracing a large number of diverse interacting parts. This system is inter alia pervaded by spillovers, nonlinear processes, turbulences, far-from equilibrium situations, small changes with big cascading or escalating effects, and cumulative and reflexive causation (causes of events are emerging in time). As a corollary, our socioeconomic innovation ecosystem (i.e., of which elements are represented along a set of institutions and organisations being in the public sector (state) on various levels, private sector, or the civic sector) is an open, adaptive complex system featured with the characteristics mentioned above.

In an effort to better grasp secular stagnation, the concept of self-organised criticality (henceforth, SOC) is worth being applied on technoeconomic paradigmatic shifts. In this way, we can refine the reasoning on secular stagnation in a more comprehensive way. SOC reflects that a complex system, such as the socioeconomic system, may easily possess a self-organising attractor dynamic phase that has an inherent potential for abrupt transitions of a wide range of intensities (Bak et al. 1988). Because the state is an attractor, the system will eventually and spontaneously return to it after each transition in time. Even though the SOC concept has its own shortcomings—as always in science with respect to approaches in better grasping reality—it proved to be an instructive line of thinking about the development of socioeconomic systems.[3] For a system that is in a self-organised critical state, in other words, in a far-from-equilibrium situation with critical instabilities (Prigogine 1997), the magnitude of the next transition is unpredictable, but the long-term probability distribution of

[3] A growing interdisciplinary literature has been backing the wide applicability of SOC (or at least, its similar scenarios, like turbulence) to the socioeconomic system we live in. See the work of Bak et al. (1993) on fluctuations in economic systems, Ghashghaie et al. (1996) on turbulence, Sornette et al. (2004) on the criticality of social networks, Mandelbrot and Hudson (2006) on the phenomenon embedded into the behaviour of markets. For a more general account on SOC, see: Martin and Scarpetta (2012) or Aschwanden (2013).

event magnitudes is a well-known distribution called "power law" (Aschwanden 2013). The theory of a technoeconomic paradigm means that the socioeconomic development has a cyclically evolving pattern driven by technological revolutions (Big Booms) by forming a new technoeconomic paradigm (Perez 2010). This concept converges to the thinking of Kondratiev (1935) and Rennstich (2002), who claim that, beginning with the Industrial Revolution in England at the very end of the 18th century, the world economy has experienced technological revolutions every 40–60 years.[4] Each technological revolution has an installation (Phases 1–2) and deployment periods (Phases 3–4) (Figure 1) and each employs new or relatively new technologies via the method of smart combination. The new ICT-based technoeconomic paradigm that emerged in the early 1990s not only provoked profound changes in the production process, but also tailored them to a more service-oriented economy.[5] Importantly, this new technoeconomic paradigm became the fertile ground for the emerging Industry 4.0 and the Digital Economy as a whole.

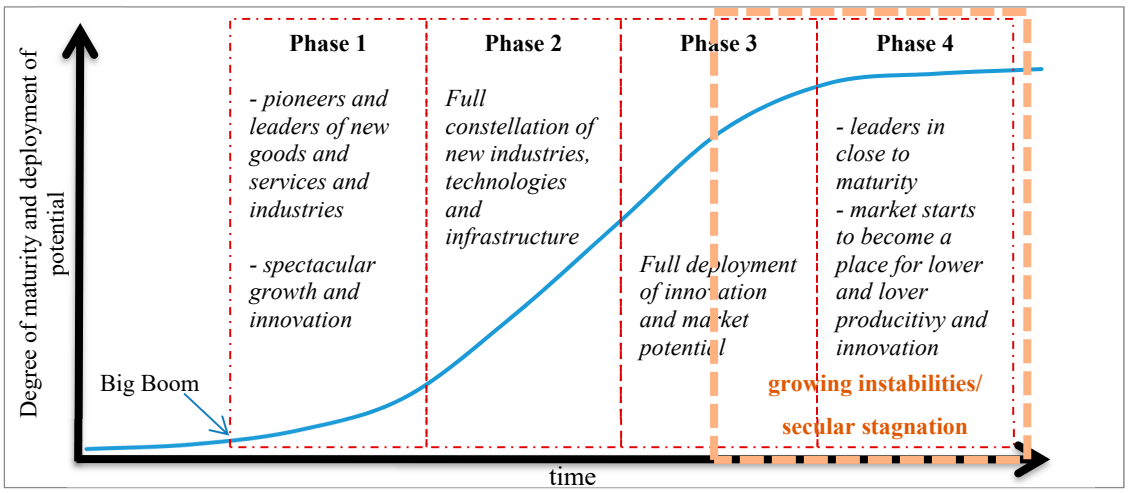

Figure 1. Life-cycle of a technological revolution and the secular stagnation.

One of the most pivotal signs of the existing criticality of today is not only secular stagnation, but also the widely perceptible backlash against globalisation. Many people feel that they have been left behind and the globalisation machine does not seem to be working for all (i.e., more and more stranded communities, problematic distribution of benefits of the globalisation). The consequence of this is the weakening trust and confidence in national and supranational governance, in the European integration process, ultimately, in the institutions evolved organically over the last decades. Ultimately, decreasing trust can feed into increasing uncertainties by raising criticality (manifesting, for example, in secular stagnation).[6]

3. Complex Nexus behind Increasing Criticality

One may righteously ask, what are those uncertainty-triggering inherently developing instabilities (complex processes) that have been directing toward secular stagnation as an attractor of socioeconomic development in the new technoeconomic paradigm at the dawn of Industry 4.0? The backlash against

[4] According to Perez (2010), the following technoeconomic paradigms can be mentioned with the big boom events: (1) Industrial revolution (1771, the opening of Arkwright's mill in Cromford); (2) age of steam and railways (1829, "rocket" steam engine for the Liverpool–Manchester railway); (3) age of steel, electricity, and heavy engineering (1875, Carnegie Bessemer steel plant opens in Pittsburgh, Pennsylvania); (4) age of oil, automobile, and mass production (1908, first Model-T out of the Ford Plant in Detroit, Michigan); and (5) age of information and telecommunication (1971, Intel microprocessor is announced in Santa Clara, California).

[5] For more on services orientation and the increasing importance of service innovation, see: Kovacs (2011).

[6] For instance, trust in national governments and in national parliaments has been declining. An increasing majority of Europeans distrust national governments, see: European Commission (2018, p. 12).

globalisation, that is to say, the increasing criticality is, at least, due to the interplay among intertwined wicked challenges affecting governance in many aspects. Without being exhaustive, we mention the following ones:

(i) Demographic challenge, such as ageing population, increasing income, and wealth inequalities and impoverishment.[7] Ageing population entails a society demanding at least new types of public services and also more prolonged treatments for the elderly, but its ultimate consequences are unsustainable pension and social systems requiring a more tailored, reflexive, and resilient public administration; what is more, the migration crisis in Europe also raises challenges for public administration (legal conditions, migration management, etc.).

(ii) Climate change, including air pollution, intensifying extreme weather anomalies, increasing temperature, etc. Climate change triggers more awareness on prevention and mitigation of the effects of climate-change-related events (disaster, air-pollution-related health effects, etc.) by calling for more proactive, more holistic public administration with increased capacity to plan, design, implement, and evaluate in the interest of greening the economies and public sectors out.

(iii) Broken harmony between the financial sector and the real economy (i.e., the financial sector does not seem to be an efficient intermediator any longer, but it has been showing a parasitic-like behaviour by becoming a financial casino). This is mainly because preferring financial investments in a more dedicated way over investments in the real economy, where the focus would be on riskier technological or nontechnological innovations and R&D activities, has become the new norm.[8] It can be captured by many indicators (e.g., the intensifying rate of share buybacks, for example, excessive credit consumerism; labour shares of income have been declining, while capital share of income has been growing, etc.). An important feature of this system evolving is the inherent bias towards larger firms. In this way, there has been an increasingly serious inequality across companies (among global frontier and laggard firms)[9] with many innovation–freedom deleterious effects stifling down the performance of the innovation ecosystem.[10]

(iv) Changing characteristics of emerging markets (i.e., becoming more service- and consumption-driven, like Chine, by being accompanied with a conspicuous slowdown in economic growth having non-negligible impacts on the world economy elsewhere via many channels).

(v) The sui generis sovereign debt crisis of 2008, including the Eurozone crisis and its aftermath, resulting in limited fiscal capacities to stimulate the economies. It is hardly by chance that one of the most influential economist duos, Carmen Reinhart and Kenneth Rogoff, considered the period 2007–2018 as a decade of debt already in 2011 (i.e., low interest rates, combined with low

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7 Including chronically increasing income and wealth inequalities (e.g., the real median household income has been stagnating for more than 20–25 years in OECD countries, where the richest 10% earns 10 times more than the poorest 10%; the wealthiest 1% owned almost 20% of total household wealth, while the bottom 40% owned only 3%). In addition, the social elevator seems to be out of order, because, on average, 4.5 generations are needed for those born in low-income families to approach the middle class. *Source*: OECD.Stat.

8 The end result of this pattern is the lack of productive private investment. This is per se reminiscent of the stagnation hypothesis coined by Hansen (1939) with respect to the US by the end of 1930s.

9 See: Andrews et al. (2016).

10 An important feature of this system evolving is the inherent bias towards larger firms becoming dominating and being more willing to use patents strategically, leading to difficult entrance of start-ups, medium wages stagnation, intensifying the jobless character of anaemic growth, secular stagnation of productivity, and, thus, moderated innovativeness (i.e., contributing to the wicked problem of secular stagnation, increasing income inequality, etc.). These larger firms are more able to initiate vertical restraints parallel with using patents to reduce risks associated with their expensive R&D and innovation activities—i.e., exclusive deals with a downstream firm, for instance, a manufacturer which then is only allowed to sell the products of that larger firm, leading to partial foreclosure of other competitor companies (Sovinsky et al. 2016). Larger companies are more likely to use patent thickets—patents belonging to them to protect overlapping technologies, which decrease entry of newcomers (Hall et al. 2016). In addition, since Industry 4.0 requires substantial R&D and innovation investments, which is even more difficult to do for younger smaller firms, this phenomenon can become even more intensive, endangering healthy competition. It will also affect the relevancy of patents as a whole.

growth, high debt, and populist pressure, can lead to fiscal crises).[11] Importantly, countries with the necessary fiscal space have achieved less GDP loss after the 2008 crisis hit compared to those that did not have enough fiscal space, which suffered from more voluminous declines (Romer and Romer 2017).

(vi) The prime example for the negative attitude toward globalisation through increasing protectionism and nationalism is the looming "global trade war", initiated mainly by the United States in the form of trade barriers and sanctions.

The resultant gradient of such simultaneously developing and mutually reinforcing wicked challenges is, to a large extent, responsible for a self-organised criticality (e.g., some sort of a 'fossilised' innovation ecosystem has emerged, manifesting in secular stagnation) inbuilt into the socioeconomic innovation ecosystem.

Although many observers are inclined to believe in a revolutionary role of the ongoing Industry 4.0 and the Digital Economy in the sense that it will reignite spectacular productivity growth (i.e., re-entering phase 1–2-like development path), our study is to demonstrate that this new technological development can be seen as a potential source of criticality strengthening.[12] In the following, the major intertwined and interrelated trade-offs and uncertainties looming around Industry 4.0 will be collected, representing a good deal of inertia forces (IFs) undermining the impressive productivity-boosting character of the process.

3.1. IF No. 1—Trade-Off between Fast Diffusion and Trust

The first trade-off giving inertia into the development of the new technological revolution comes from the disruptive nature of Industry 4.0 solutions on tangible and intangible spheres. For the tangible sphere, the unfolding phase will surely have opponents (partly being able to organise their opposition in a more effective way). For instance, the ever-widely available new platforms (such as Uber, Airbnb, Spotify, Liquidspace) have the potential to destabilise traditional professions and sectors by triggering collective protests (e.g., since the decade-long form of the US housing market's regulatory and operational model does not fit into the Airbnb system, protesting started in San Francisco, and the city of New York also restricts the use of Airbnb).[13] Logically, preferring the status quo is not the touch of evil itself, since it safeguards some sort of stability in society, especially if one also considers that overcoming disruption (i.e., re- and upskilling in an effort to be successfully absorbed elsewhere in a sustained way as a reaction to intensifying robotics and automation) seems to be much harder than ever before in history.[14] If it holds, the indebtedness of the corporate and household sectors will do nothing but deteriorate further, aggravating inequalities (possibly undermining political stability and legitimacy).

Undoubtedly, hyperconnectedness and the emergence of cyberphysical systems are by no means uninterruptible and indestructible. Thus, the second potential trust-demolishing channel is the unresolved issue of cybersecurity. The growing body of evidence about it fuels an increasing fear in society regarding how fast we should desire a fully digitised and interconnected industrial ecosystem, and a digital economy as a whole.[15] One of the intriguing questions is whether we should go for

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[11] In spite of the known shortcomings with respect to the Economic and Monetary Union (i.e., the Eurozone is not an optimal currency area) at the very beginning, Bordignon et al. (2018) showed that any kind of convergence in terms of public services, product, and labour market regulation, and the quality of institutions and the future of the EMU is riding on political will rather than the sheer economic considerations.

[12] For a more comprehensive account on Industry 4.0, see: Kovacs (2017).

[13] The expected progress of self-driving vehicles beyond peradventure will cause a shift in the landscape of land transport (taxi and trucks) and inland waterway as well as maritime transport alike, endangering many jobs.

[14] For more on deskilling and on the cumbersome upskilling, see: de Pleijt and Weisdorf (2016); Krzywdzinski et al. (2016); or Acemoglu and Restrepo (2018).

[15] A survey conducted by Chapman University in 2016 showed that, after corruption, what Americans fear the most is cyberterrorism. Available: http://www.usatoday.com/story/news/nation-now/2016/10/12/survey-top-10-things-

cyberphysical systems with a unified architecture to unleash its full potential or pluralism (i.e., a set of different architectures used simultaneously) seems to be more resilient or antifragile (i.e., it can even be improved after a serious attack).[16] If the general impression becomes dominated by a picture of an unsolved cybersecurity standing on ruddy legs, the pace of Industry 4.0 diffusion can, all without doubt, suffer, making its desired powerful productivity impact highly questionable. Let us also note that absolute security with zero uncertainty is wishful thinking, since full security would require a rather limited operation of the existing digital infrastructure (including the application of Industry 4.0 technologies). Moreover, the greater the role and power of cybersecurity state authorities, the greater the power of the state, potentially having an even more extended scope for abuse. In this way, uncertainty would also rise to unprecedented levels, slowing down the diffusion of Industry 4.0, hence restraining the productivity growth expected.

As far as the intangible sphere is concerned, ever-more digitalised environments and living styles may have a detrimental effect on people's mental (and even physical) health. With the development and spread of information and communication technology-based (ICT) Industry 4.0 and Digital Economy solutions and applications, employees not only have become available 24/7, potentially undermining work–life balance, but they can be monitored and controlled more easily than ever before via algorithm-oriented management.[17] More and more studies and surveys have dealt with the issue of whether the excessive use of ICT (e.g., real-time data-based analytical methods for monitoring the work of employees through various channels) can be harmful for the mental and physical health of people.[18] Therefore, efforts to avoid serious mental health problems can also ricochet off an unleashed Industry 4.0 (e.g., for the first time in known history, robots can be more skilful than humans; thus, the need to compete even with machines can be considered as a significant source of mental stress).

As a corollary, direct, significant, and lasting governmental support in favouring intensive development of the Digital Economy might have a demolishing effect on trust and confidence, a trade-off to be reckoned with by a complexity-oriented economic governance.

3.2. IF No. 2—Regulation over Labour Market

According to analysts, there has never been so much demand for flexible labour markets than at the dawn of Industry 4.0 and the Digital Economy due to the increased need of companies for quickened hiring of more productive workers (i.e., talented and highly-skilled creative workers) as well as firing of less productive ones (i.e., less innovative employees). This assumption is in line with the conventional wisdom of economics stating that a more inflexible labour market—meaning higher transaction costs when it comes to hiring/firing due to higher employment protection—tends to stifle down innovation due to less efficient reallocation mechanisms negatively affecting productivity growth by not creating space for wage increases, as a necessary prerequisite of workers' motivation to be risk-taker and innovative.[19] However, in the meantime, the world economy has become ever-more

americans-fear-most/91934874/ Accessed on: 11 January 2019. It is hardly by chance that Andrews et al. (2016) documented that not only the number of reported industrial control incidents, but also the number of cyberattacks against manufacturing firms have been conspicuously growing, initiated by ransomwares, malwares, and various types of phishing activities, engendering smaller-scale and also full disruptions (e.g., in public services as well).

16 Zezulka et al. (2018) pointed this out with respect to the communication challenges across Industrial Internet of Things.

17 E.g., the so-called People Analytics for the purpose of selecting as well as hiring, then monitoring the best candidates for a job, as Isson and Harriott (2016) demonstrated.

18 See Cathy O'Neil's book (O'Neil 2016) on how algorithmist organisational environments can cause '*math-destruction*' in this respect, leading to deteriorated morale, stressful work, and a culture of anxiety being interspersed with mental and even physical diseases.

19 For more on the reallocation channel, see: Martin and Scarpetta (2012). Of course, not only the tangible (salaries/wages, bonuses etc.), but also the intangible (e.g., autonomy, space for self-realisation, increased responsibility) part of the incentive regime matters (See: Beck-Krala et al. 2017), whose power can be curbed in the case of extensive ICT-based monitoring and control, encoding the culture of anxiety mentioned above.

complex, overshadowing the explanatory and predictive power of such theoretical assumptions.[20] For instance, the US, which has been being equipped with one of the most flexible labour markets, has been showing stagnating real wages for decades; what is more, the increase of the income of the middle class has been infinitesimally low in the period 1979–2011 (Komlos 2016). Compared to this, the European Union (EU) shows a little bit better picture with moderate increases (Nolan et al. 2016, p. 6) even in terms of labour force participation, which has been rising since 2000; this is exactly the opposite of what one can observe in case of the US.[21] Consequently, a more flexible labour market is not a guarantee of positive developments (especially in a socioeconomic constellation in which the financial sector dominates at the expense of the real economy, as indicated earlier). What is more, some estimate that by the sheer introduction of US-like labour market flexibility in the European context, even the share of highly-skilled employees within the total employment would ceteris paribus decrease.[22] Unfortunately, they are the ones with more complicated knowledge, the work of whom, with the help of automation (and/or robotisation), enables employers to realise even greater cost-savings. Bearing in mind the potential job replacement rates given by the rapid and wide use of automation (e.g., OECD average is 57%, 47% in case of the US, 54% is estimated for the EU, 77% for China),[23] hacking inclusive growth is definitely in the cards, especially in an era characterised by stagnating real wages, productivity growth becoming increasingly anaemic, and chronically rising inequalities.

Paradoxically, under current circumstances, wage increases seem to be necessary to motivate workers to be more innovative, whereby propping up productivity growth can become a real perspective (i.e., the old wisdom of economics saying that productivity growth comes first and then wages can go up is blurred in the face of the current socioeconomic constellation)[24]; however, such cost-heightening actions, at the same time, can be seen as a coercive power directing companies towards intensified cost-reducing and productivity improving automation/robotisation. Not to mention that such a direction can be quickened in the case of an intensive deregulation of labour markets. And since there is no more effective market incentive for companies to purchase and install newer and newer but more expensive machines than the continuously growing wages as well as salaries (Nakamura and Zeira 2018), national governments must decide whether they are pursuing a value-congruent, inclusiveness-oriented growth and development path or they are letting automation and robotisation flourish in favouring productivity growth (which is still a big if).[25] Since the principle of inclusiveness has become one of the focal points, not only in the EU[26], but also in the view of other international organisations,[27] there is an inherent counterincentive to the rapid diffusion of Industry 4.0-related technologies. All in all, expecting the spectacular return of productivity growth via extensive deregulation of EU labour markets in a one-size-fits-all manner is just a forlorn hope.

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[20] If one looks at patterns discernible in World Development Indicators of the World Bank, it can be shown that previously, if employment expanded, average wages had risen, or at least public revenues had increased; this trend cannot be identified today. At a time when productivity increased, it was accompanied by wage growth, but today it is not necessarily true.

[21] Source: Eurostat (lfsi_emp_q).

[22] See: Andrews et al. (2016) or Allcott and Gentzkow (2017) in emphasising that even the high-wage occupations will not remain resistant to automation and robotisation.

[23] Source: Statista, Citigroup, World Bank.

[24] This nexus is therefore not a one-way street, as economics with '*mathiness*' (Romer 2015) is presupposed for a long time, as the work of Earle et al. (2017, p. 174) raises. Wage/salary increases are also of crucial importance to cope with the increasingly worrying trend of shortage of labour, particularly in the case of Central and Eastern European Member States. For example, Hungary has become a net exporter of talents, and the personal remittances (% of GDP) received have more than doubled in the period 2010–2017, see: World Development Indicators.

[25] In a recent survey by Capgemini Research Institute, 58% of company respondents reported that the positive impetus of automation on productivity was actually invisible. Available: https://www.capgemini.com/wp-content/uploads/2018/11/Report-%E2%80%93-Upskilling-your-people-for-the-age-of-the-machine.pdf Accessed on: 11 January 2019.

[26] See: Europe2020 Strategy or the Annual Convention for Inclusive Growth.

[27] See: OECD Inclusive Growth Initiative. Not to mention the Sustainable Development Goals of the United Nations accentuating the promotion of sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all. Fecent work, among others, offers work–life balance in a more dedicated and flexible way, which is required more and more by generation Y. See: Allcott and Gentzkow (2017).

3.3. IF No. 3—Trade-Off between Reality-Oriented Politics and Post-Factualism

After decades-long entanglement of wicked challenges, described earlier in this paper, wage stagnation or infinitesimally low increases as well as chronically increasing inequalities are coupled with the dispiriting trend in productivity featuring low growth, culminating in the emergence of domestically disintegrated economies in developed countries (even in the integrations of developed countries, like the EU).[28] This implies at least that more and more people have turned away from politics, feeling that they have nothing to do with it.[29] Distrustful behaviour in politics and governance has therefore gained momentum in a form of flaring populism, secessionism, and protectionism, even in the European integration. According to the European Social Survey, compared to national parliaments, the confidence in the European Parliament is greater only where domestic performance is weak. Surprisingly, as Dustmann et al. (2017) illustrate that at present, older people with lower qualifications support the EU less.

In the past, usually most people (voters) listened to what experts as well as policymakers said, and they developed their opinions and decisions accordingly. Today, it seems that the "age of listening" has, to a large extent, ended because of a set of issues mutually reinforcing each other. In a nutshell, (i) on the one hand, extensive digitalisation and the use of the Internet offer much greater space for people (including experts) to express their opinions; on the other hand, informational overload has become ubiquitous; (ii) there are too many so-called experts whose opinions tend to be increasingly controversial; (iii) the world economy has become utterly complex to analyse, making it less and less possible to draw clear conclusions; (iv) for this reason, predictions, suggestions, and conclusions are becoming less and less reliable. This process is particularly conducive to the rise of populism and some kind of post-factualism.

It may seem that by now, there is an increasing demand for a post-factual-oriented, opinion-driven governance (doxocracy), as well as social order. In our view, the main problem is not with political populism and the tools used for manipulation; the main challenge is rather that it does not seem to matter to the society any longer whether politics or the government seek factualism or not (e.g., think of the misleading initial promises of the UK Independence Party arguing for Brexit). The famous French sociologist–philosopher Jean Baudrillard coined the term simulacra to capture the triumph of delusiveness over (often ugly) reality.[30] Undoubtedly, simulacra has already had a systemic effect. For instance, there would not have been excessive indebtedness of nation states with severe negative repercussions in various domains if voters had punished governments choosing fiscal alcoholism at time of elections; income and wealth inequalities would have been much lower if voters had not supported governments deciding to diminish progressivity from the tax system; and finally, if voters had not chosen some sort of conscious ignorance, then those turning away from governments imposing austerity measures would not have preferred populist and nationalist streams but rather those emphasising the necessity of sacrifice in an effort to implement developmental missions.

An implication of a kind of governance preferring simulacra (i.e., a manipulated perception over reality) is, inter alia, that governments are likely to prefer doxocracy over wanting to base their decisions on properly collected and scientifically adequate data obtained and published by national statistical offices. The word 'statistics' originates to a large degree in 'state' indicating that the nation state has always ordered some sort of accounting to have a better picture about what is really going on in the economy. However, with the development of Industry 4.0 and the Digital Economy, measurement shortcomings may distort our picture of reality. Just to name a few weaknesses of

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[28] As a corollary, suppressed tensions are the new norm waiting for breaking up either like a subterranean stream breaking the surface or volcano eruption causing serious structural changes (e.g., the rise of Trump, vote for Brexit in the United Kingdom, and at the time of writing this study, yellow vest protests in France since November 2018).

[29] In this way, peripheral regions have emerging. In case of France, see: Aschwanden (2013).

[30] See: Baudrillard (1981). For example, at the end of the 2016 US presidential election campaign, the number of fake news posts on Facebook outnumbered that of the real ones with respect to the election. See: Allcott and Gentzkow (2017).

our statistics: (i) Since ICT are almost and soon will be everywhere and in everything (Internet of Things), differentiating between products with ICT and those without it is getting harder and harder; (ii) putting various new occupations and professions into our traditional classification has become a real challenge (e.g., software developers, digital content providers, self-employed knowledge workers etc.); (iii) more granular Big Data is not the panacea either, simply because such databases do contain discretionary correlations, and Internet-based searches to use near real-time data called nowcasting, all the more, are likely to make our picture of reality even more distorted[31]; and (iv) with the pervasive digitalisation of the economy, its intangible feature has been growing, bypassing the perspectives of the statistical offices being biased toward the quantifiable aspect of our lives but not toward the more qualitative part of it.[32]

While the desideratum of today is to initiate productivist economic policies in supporting the reintegration of domestic economies across the board (i.e., to reinvigorate trust and confidence) by building on evidence-based (relevant, timely, and usable data-driven) policies[33], the culture of simulacra serves as an obstacle to it. In addition, Industry 4.0 and the Digital Economy, as we indicated above, do not necessarily make us more able to have a better picture of reality. Consequently, one can see the contour of a trade-off between reality-oriented and post-truth politics which might be powerful enough to bring hysteresis into the development of Industry 4.0.[34]

4. An Illustrative Case: Hungary

4.1. IFs a la Hungary

As for IF No. 1, in 2015, the revolt of the Hungarian taxi drivers against the platform Uber neatly illustrated the increasing tensions due to new digital technologies (platforms). In addition, in early 2017, the Hungarian Hotel and Restaurant Association expressed its concerns about the ever-more increasing use of Airbnb by providing a potential roadmap toward whitening out Airbnb-based businesses with the help of the government together with the National Tax and Customs Administration. In addition, and despite the rising awareness over the crucial importance of cybersecurity (e.g., the new national cybersecurity strategy was accepted in January 2019), Hungary could not avoid serious cyberattacks against public institutions (e.g., against hospitals during 2016 via ransomwares like Locky and CryptoWall 4), raising concerns over the fragility of public services.

As for IF No. 2, for a relatively long time, the strictness of employment protection in Hungary has been below that of the OECD average.[35] Still, with the approval of the newest amendment of the Labour Act by the Hungarian Parliament in a rather unprecedented and chaotic way in December 2018 (i.e., voting for the so-called Slavery Act (Overtime Act), which has become effective as of 1 January 2019, meaning the possibility to raise overtime hours from 250/year to 400/year on a voluntary basis, overriding even the collective agreements with trade unions), the Hungarian labour market regulation has become *seemingly* more flexible. As we discussed earlier, pushing a more flexible labour market is not a panacea per se, potentially injecting additional uncertainties into the socioeconomic innovation

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[31] See: Richardson (2016).

[32] See: Haskel and Westlake (2018).

[33] Policies can artificially be made up as seemingly productive ones, but eventually they can turn out to be damaging (i.e., having bubble-generating power). For instance, in Shenzhen (China), there were only 200 companies specialised in robotics development in 2014, but now, that number is over 2000.At present, the predominant share of company net profits (specialised in robotics and automation) is coming from governmental subsidies. See: http://knowledge.ckgsb.edu.cn/2016/12/21/manufacturing/china-worlds-automated-factory/ Accessed on: 11 January 2019.

[34] A more and more ubiquitous phenomenon is that budgets of national statistical offices have been declining; hence, statistical offices will not necessarily be able to invest in new technology and production processes and establish partnerships with new actors in the interest of offering relevant, granular, timely, and usable data for better informed policies. One might assume that politic is not pursuing such a direction so inexorably. This is why, for example, international organisations have become the pioneer of establishing new methods for measuring the evolvement of the Digital Economy (also encapsulating the 'beyond GDP' research programmes).

[35] For instance, for the year 2013, the Hungarian value was 2.07, while the OECD average was 2.28). See: OECD.Stats.

ecosystem, especially in the case of Hungary.[36] Bearing in mind the constellation of (i) intensifying shortage of (skilled) labour via brain drain[37] interspersed logically with (ii) the increasing dependency of households on remittances coming from expatriated workers[38], accompanied with (iii) ever-more heightening inequalities and impoverishment[39], recent changes in labour market legislation can be seen as a faux pas rather than a promising step toward bettering the productivity outlooks of Hungary.[40] Although these altogether may form a coercive force toward a non-inclusive Industry 4.0 development strategy of Hungary, the positive impetus of such an orientation on productivity can be questioned on many grounds (e.g., supporting companies to purchase the newest Industry 4.0-related technologies would be nothing more than giving them expensive toys without professional knowledge).

With regard to IF No. 3, after 2010, the key characteristic of the Hungarian economic governance has been the establishment of a Max Weberian plebiscitary leadership democracy being pervaded by a good deal of simulacrum (post-factual governance with extensive nationalism and macroeconomic populism).[41] The major components of such system can be juxtaposed as follows: (i) A series of governmental measures in autocratic fashion increasing uncertainty and critical instability in the Hungarian innovation ecosystem on the one hand, while cementing the leading group to be immutable and not voted out of office on the other;[42] (ii) post-factual-like considerations in economic governance spanning from a fight for economic freedom through ill-based communications of governmental achievements. As far as the economic freedom war[43] is concerned, it was with a scent of a growing negative attitude toward globalisation, which cannot be a plausible and sustainable development-congruent strategy simply because of the

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[36] For a more comprehensive account on Hungary, see: Kovacs (2016).

[37] Hungary was considered a net exporter of talents according to IMD World Talent Ranking 2017. It performed much worse than its Central European peers, the so-called Visegrad group (Czech Republic, Poland, and Slovakia).

[38] The personal remittances received (in % of GDP) have been by far the greatest in Hungary compared to other Visegrad countries. That volume accounted for 2% of the GDP in 2010, while it had skyrocketed over 3.3% by 2017 due to a significant emigration of people. According to the Hungarian Central Statistical Office, almost 175,000 people have left Hungary since 2010.

[39] In 2016, among the Visegrad group, only the Hungarian rate of risk of poverty or social exclusion (26.3%) exceeded that of the European Union average (23.5%). According to OECD statistics, income and wealth inequalities in Hungary tend to be large. Moreover, now, it takes 7 generations for a child born in a poor family to get into the middle class. Unsurprisingly, Hungary suffers from a comparatively surpassing share of well-being deprivations, with 12 out of 18 deprivation indicators ranked in the bottom (most deprived) third of OECD countries (OECD 2017).

[40] The Hungarian trajectory in terms of labour productivity (measured in GDP per hour worked, 2010 = 100) has been by far the worst amongst Visegrad countries since 2010 (See: Source: OECD Productivity Statistics: GDP per capita and productivity growth).

[41] A form of governance which perpetually refers to the people's will, but its original intention is to transform that will to its own purposes. Such a system necessitates and is built on a strong charismatic leader alone representing the political elite, which shapes rather than follows the public will. See Urbinati (2014).

[42] For in-depth analyses on the autocratic fashion, see Kornai (2015, 2017). The main measures were as follows: Eradicating the original form of Hungary's Fiscal Council; amending the constitution and adapting the authority of the Constitutional Court to the planned laws and regulations in an ad hoc fashion; introducing special taxes on the energy, telecommunications, retail, and banking industries that discriminate against foreign companies; rejecting any commitment to preserving and strengthening the sanctity of private property by nationalising private pension funds; introducing flat income taxes, which are more beneficial for high earners; reducing the autonomy of higher education and cutting its budget by HUF 84 billion between 2010 and 2013; strict regulations on the media; and establishing and adopting Hungary's new Fundamental Law, which inter alia constrains the power of the Constitutional Court and limits the room for manoeuvre of future governments without a two-thirds majority. In 2014, the Hungarian prime minister explicitly expressed the government's ambition to create an 'illiberal democracy'. In addition, independent media suffered from serious attacks (e.g., as Freedom House documented, Hungary's largest independent daily, *Népszabadság*, which had uncovered a string of scandals involving the ruling party, was unexpectedly suspended in October 2016, available: https://freedomhouse.org/report/freedom-press/2017/hungary accessed on: 11 January 2019). An increasing share of the Hungarian Public Finance has been spent on communication in an effort mostly to rebel against Brussels, to communicate how dangerous the migration crisis is, etc. Even in 2018, approximately EUR 150 million was spent on communication by the government. In 2018, beyond the approval of the amendments to the Labour law (Slavery Act mentioned earlier), the Hungarian Parliament also passed a law on establishing a new system of administrative courts under the firm control of the Minister of Justice, meaning that a separate court system will be responsible for decisions in which Hungarian authorities are affected or involved by endangering judicial independence. Attacking renowned higher education institutions together with the Hungarian Academy of Sciences by removing its financial autonomy contributed to a series of demonstrations as well.

[43] The term '*fight for economic freedom*' was repeatedly used in governmental speeches (e.g., it was used in a speech in the Hungarian parliament on 21 November 2011 delivered by the Minister of National Economy with respect to the IMF credit agreement).

hard-won lesson of development economics stating that globalisation is irreversible and no one can stay out of it if a real development is considered a value by the government (i.e., sharing international knowledge to innovation dynamism). Moreover, Hungary relies on the EU asymmetrically, since 97 per cent of all public investment in the country is financed mostly by the European Union; thus, turning against Brussels is based on nothing but post-factual false beliefs. In this respect, the new orientation in foreign policy (the so-called Opening to East strategy) has not led to the desired outcomes so far.[44] With respect to communication, the Hungarian government has been triumphantly publishing seemingly positive messages in the state-owned media (e.g., the historically low level of inflation which, in reality, implied frozen or delayed real investments; growing employment, which was mainly due to the increased public employment and compulsory worker activity[45]; communicated the utility price cuts as a real development in the interest of Hungarians, while this step actually led to prices being above the world market prices for energy carriers).

4.2. Survey Insights and Steps Forward?

The Hungarian Industry 4.0 landscape is, therefore, not without the big IFs we elaborated along this paper. By filtering out the major insights of recent surveys on the perspective of Industry 4.0 in Hungary, the followings emerge: (i) To date, 60% of respondent manufacturing companies in Hungary do not apply any smart manufacturing systems or solutions; (ii) those companies are in great need of information and knowledge transfers as well as concrete solutions regarding Industry 4.0 development (44% of respondents pinpointed both the lack of information and knowledge and the high costs of implementation as primary hurdles to progress in that direction);[46] (iii) 90% of respondent firms operate with a soupçon of R&D expenditure base within the range of 0.1–3%; (iv) while Hungarian respondents reported one of the highest levels of supply production information integration and that of the customer production information integration compared to those in other regions analysed (Upper Austria, Lower Bavaria, Veneto, Emilia Romagna, and Lower Silesia), this perception has not really been mirrored in terms of outcomes (i.e., Hungary is considered as a medium performer in production and process innovations);[47] (v) most Hungarian manufacturing firms are predominantly expecting benefits from adopting Industry 4.0 solutions in terms of significant cost reductions as well as time savings to reach out to markets.[48] Thus, neither productivity improvement nor large-scale job creation are considered clear goals for them. Keeping in mind the IFs with respect to Hungary, it is not surprising that the lack of skilled labour and adequate training as well as the widely perceptible digital illiteracy were repeatedly reported as major obstacles to ground Industry 4.0 development.[49] Consequently, the current state of affairs of manufacturing firms calls, at least, for a more complex development and training programme.

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[44] See: Kozár and Neszmélyi (2017).

[45] These fields absorbed almost 80,000 people in the period 2008-2013. Another telling fact was that, in 2014, the government did not allocate financial resources for the Central Statistical Office to carry out researches on poverty or socioeconomic inequality.

[46] See the survey within the project Smart Factory Hub involving 280 manufacturing firms from 10 countries, available: http://www.interreg-danube.eu/approved-projects/smart-factory-hub Accessed on: 11 January 2019. Furthermore, a recent survey, a joint undertaking commissioned by the Industry 4.0 National Technology Platform—see Haidegger and Paniti (2016)—with the aim of assessing the Industry 4.0 readiness as well as awareness of domestic manufacturing companies revealed that not only large, but also small and medium-sized (SMEs) Hungarian companies are mostly lacking a systemic strategy for Industry 4.0 (the share of those not having strategy at all was 66% in case of large companies, while it was 36% in case of SMEs).

[47] OECD (2018, p. 124) pointed out that except the mainly foreign-owned export sector, the domestic SME sector has low growth, productivity, and propensity to innovate.

[48] See the survey within the project InnoPeer AVM involving 163 manufacturing companies from 5 countries (30 from Hungary), available: https://www.interreg-central.eu/Content.Node/InnoPeerAVM.html Accessed on: 11 January 2019.

[49] The Digital Economy and Society Index, developed by the European Commission, also suggests that Hungary belongs to the bottom third in terms of maturity among European countries. Slovakia and the Czech Republic outdid Hungarian performance. See: https://ec.europa.eu/digital-single-market/en/desi Accessed on: 11 January 2019. If one looks at IMD World Digital Competitiveness Ranking 2018, Hungary seems to have been deteriorating (while Hungary was ranked at the place of 36th in 2014 out of 63 countries, it then fell to the 46th position in 2018).

The recognition of the inhibiting factors mentioned brought to life some policy reactions; one of the most promising programmes is the so-called HGC Academy[50], concentrating exclusively on manufacturing firms showing high-growth potential (HGC as high-growth companies in terms of job creation and productivity).[51] The HGC Academy offers a range of services (seeking international best practices, organising workshops across Hungary for firms motivated and competent enough to take part in the project[52], mentoring, practical trainings, and education for the selected 40 companies, etc.) and its uniqueness also comes from the fact that it considers launching the so-called Prototyping Innovation Centre for selected firms. The Centre will be equipped with all the necessary Industry 4.0-related technologies and nontechnological solutions to showcase and to be used for prototyping. Thus, it differs from other well-known concepts (e.g., technology transfer offices, innovation (and business) incubators, (innovation) clusters, innovation/technology parks, and various innovation agencies) since it is sought to help manufacturing firms in real developments at technological level. It will not merely serve as a model factory, but a place where prospective Industry 4.0-based production and economic processes can be modelled, tested, and where new, innovative products can be incorporated into production processes.

Still, the shortly presented IFs in Hungary call for a reality-oriented economic governance in reinvigorating the dynamism of the innovation ecosystem in a complex way (e.g., a governance cultivating ecosystem which is to breed, develop, attract, and preserve talents as a critical base of any kind of Industry 4.0 transformation by eliminating uncertainties, etc.). Without a significant turn in economic governance, it is quite likely that a strictly industrial development-oriented governance would only increase the criticality in the system without generating real and sustained socioeconomic values.

5. Concluding Remarks

Theoretical and empirical studies on Industry 4.0 are in rise; however, a more balanced and complexity-aware approach (i.e., dealing with complex nexus) has still not gained traction in the academic literature. The added-value of our paper to the available literature emanates from bridging this gap by digging a little bit deeper in the analysis on the potential productivity impact of Industry 4.0 with a more systemic view, hence going beyond the optimistic expectations of studies written in an ecstasy of adolescent enthusiasm.

Our paper conveys at least two important lessons for theorists and practitioners, either at national or supranational levels.

First, the productivity-boosting character of Industry 4.0 is still a big if, bearing in mind the IFs presented in our paper. Cautiousness is therefore in order for academics and economic policy engineers alike when it comes to expecting amazing productivity-enhancing impacts from Industry 4.0. We by no means state that Industry 4.0 and the emerging Digital Economy cannot be interpreted as a kind of phase-transition, as SOC suggests; what we do accentuate is that the full panoply of effects of Industry 4.0 on productivity is not as obvious as some analysts and practitioners think. Estimating that effect is like fishing in the lake of uncertainty simply because there are many inertia forces (IFs) inbuilt into the socioeconomic complex system (like in the Hungarian system); what is more, Industry 4.0 can also be considered a potential source of criticality.

Second, and still, governance has to exploit the potential of Industry 4.0 via a more systemic approach by taking into account complex nexus. On the front of economics, this implies not only that

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[50] See: https://hgc.ifka.hu/.

[51] Manufacturing companies involved meet the following criteria: A minimum of EUR 300,000 annual turnover; employment over 10 persons; operation in convergence regions (regions except Central Hungary); preferred domestic ownership; constant growth in recent years either in terms of employment or profit.

[52] The number of such companies is 153, employing more than 10,000 workers in Hungary. Sixty percent of those are with less than 20% export in their operation, 9% of those have exports above 80%, only 8% of those companies are familiar with digitalisation of manufacturing processes, and only 2% of them are experienced in Big Data analytics.

opening up is in order (i.e., towards a more plural, a more interdisciplinary, and complexity-aware economics to serve as a more fertile ground for economic governance) but also that the long-lived value-neutral economics must die (i.e., modern governance shall not be engaged in chasing final solutions to wicked challenges but in addressing them via longer term and value-based missions, i.e., sustainable development-congruent directions like inclusive growth in the face of Industry 4.0 and Digital Economy).[53] On the front of governance, general and more particular recommendations emerge. In general, (i) in the complex world economy, no nation state can face down intertwined wicked challenges alone (fighting for economic freedom is like chasing unviability); thus, broad-based collaborations with a more holistic view are needed across the board; (ii) we need a coalition of empowering states throughout the EU that places people back into the centre in safeguarding inclusive development. To the latter, effective and efficient governance relies on political stability, which is immensely dependent on the trust infrastructure in the given society. If Industry 4.0 and the ever-intense digitalisation disrupt the trust and confidence of people in governance, strengthening trust is inevitable (e.g., getting closer to the public through institutional decentralisation; investing more in people to equip them with the skills and capability necessary to resist to post-factualism and to cope with Industry 4.0 and the new challenges given by Digital Economy; broadening and widening the opportunities of people to be a valuable part and parcel of the society in a dignified way, as the case of Hungary also implies). In particular, a kind of industrial policy renaissance[54] has a perspective, but mostly in a form of establishing new framework throughout the EU, with common policy directions, which can be followed in a differentiated way (i.e., we indicated that direct, significant, and lasting governmental support does not seem to be an instructive way forward in supporting the sustainable development of Industry 4.0 due to its more trust-destructive feature). There are regions where transferring knowledge and providing concrete technological support are of more importance than the sheer financial support in general, as the Hungarian case illustrated.

Our study, of course, has a number of limitations. First and foremost, capturing the whole gamut of nexus related to the complex development of Industry 4.0 is almost impossible; we merely wanted to justify the existence of a more fossilised-like complex socioeconomic system due to the major inertia forces deciphered along the paper (e.g., we could not address the role and that of the possible changes of political inertia forces, such as the fossilised elites breeding populism and simulacrum). Second, we did not evaluate the programmes of national governments initiated in supporting Industry 4.0; we just concentrated on the major trends and nexus that have been evolving mainly onto the manner of creeping normalcy and have not been addressed so far in papers on Industry 4.0.

According to an anecdote, when Benjamin Franklin, a famous American inventor, was asked what possible good this new toy could be, Franklin briskly replied by asking back what good is a new-born baby?[55] The ongoing industrial revolution is a relatively new-born baby having great potential in enhancing socioeconomic development. In a much more complex world, economic governance must admit that full control is nothing but an illusion. For this reason, a reality-oriented economic governance shall prioritise avoiding really bad outcomes instead of being hardwired to inexorably trying to optimise the system via trust-breaker interventionism. This does not imply that governance would prefer some sort of lock-in but would recognise that the success of Industry 4.0 rests not only upon its technical feasibility, but also on its social acceptability, which grounds political stability.

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[53] The extension of corporate social responsibility in the case of industrial players can be seen as an instructive way forward, as Shpak et al. (2018) presented. For the nexus between Industry 4.0 and circular economy, see: Garcia-Muiña et al. (2018).

[54] Within the context of the European integration, speaking of some kind of industrial policy, which concept has been dissolved into the oblivion for decades, let us recall to the fact that the Treaty of Rome does not refer to any common industrial policy, but, according to the 92nd article, there is a chance for it, but: it has to be targeted, specific, temporary, and powerful, if we want to promote adaptation to a new, changed environment. This is what industrial revolution means, and this is in line with the considerations of Jean-Claude Juncker's document, called State of the Union 2017—Industrial Policy Strategy 2017, see: European Commission (2017).

[55] For more on this anecdote, see: Chapin (1985).

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