THE IMPACT OF INDUSTRY 4.0 AND AI ON ECONOMIC GROWTH

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Abstract: This study explores the impact of Industry 4.0 and AI on economic growth. The high level development of industry 4.0 and readiness using artificial intelligence doesn't provide high rates of economic growth. One of the reasons is the objective obstacles associated with the implementation of industry 4.0 and AI. These obstacles are economic, technological and institutional.

Keywords: Industry 4.0, AI, constraints of development Industry 4.0 and AI, economic growth.

1. Introduction

Issues related to Industry 4.0 and artificial intelligence are constantly discussed among scientists, businessmen, representatives of government agencies and public organizations. The role of Industry 4.0 and AI in the global and national economies, individual industries, labor, and capital markets is attracting more and more attention of economists. It is forecasted that activities in this direction will become a driver of further economic development and lead to fundamental changes in the structure and methods of production, and the quantity and quality of consumption. "Global production of information and communications technologies (ICT) goods and services now amounts to an estimated 6.5% of global gross domestic product (GDP), and some 100 million people are employed in the ICT services sector. Exports of ICT services grew by 40% between 2010 and 2015. Worldwide e-commerce sales in 2015 reached $25.3 trillion, 90% of which were in the form of business-to-business e-commerce and 10% in the form of business-to-consumer (B2C) sales" (Kwilinski, 2018, p. 8). A trend towards to

increase global e-commerce sales is preserved in the next years. According to UNCTAD[1] "global e-commerce sales grew 13% in 2017, hitting an estimated $29 trillion" (Global e-Commerce sales surged to $29 trillion, 2019).

PricewaterhouseCoopers representatives suggest that "AI could contribute up to $15.7 trillion to the global economy in 2030, more than the current output of China and India combined. Of this, $6.6 trillion is likely to come from increased productivity and $9.1 trillion is likely to come from consumption-side effects" (Anand, and Verweij, 2017, p.3). and "Labour productivity improvements are expected to account for over 55% of all GDP gains from AI over the period 2017-2030" (Anand, and Verweij, 2017, p. 3).

Great expectations were placed on the formation of a European digital market. The report prepared by the Boston Consulting Group several years ago indicated that "In the frontrunner countries also were to fully capture and benefit from expected emerging high-technology markets at a rate proportional to the size of their economies, the combined net effect with DSM on GDP growth could be an increase in excess of 80 percent, up from a 2.2 percent expected annual growth to a 3.9 percent expected annual GDP growth until 2020, placing these economies among the fastest growing in the world, adding 264 billion in annual GDP by 2020" (Alm et al., 2016).

SAP experts affirm that IoT and digital manufacturing lead to "Productivity improvements such as lower maintenance costs (up to 60%), or lower capital appropriations (25%). New operational processes resulting in lower labor cost (30%) with improved OEE[2] (5%-10%) and reduced scrap levels (30%-50%). People process optimization leading to 10% to 30% higher productivity in the form of higher outputs and lower costs. Lower risks, such as reduced warranty cost by (10%) and improved compliance through 100% component and process traceability" (Innovations for Digital Manufacturing, 2017, p. 2).

Thus, in the final analysis, the implementation of Industry 4.0 and AI should ensure substantial economic growth. And the merger of Industry 4.0 technologies and AI already allows us to talk about the formation of Industry 5.0 (Özdemir, and Hekim, 2018).

The positive assessments of the leading consulting firms in the world regarding the prospects for digitalization coincide with the opinion of the business. Three years ago, in 2016, very high expectations from the development of Industry 4.0 were recorded. Most companies expect that investments in Industry 4.0 to pay back within two years. The number of such respondents is 55%. To the question: "What return on investment period (ROI) do you expect from your digital investments?", only 8% of companies answer that such a period will be "more than five years" (Geissbauer et al., 2016, p. 25). Given the dominance of the short-term payback period (two years), a significant increase in investment in this sphere can be expected. Investments should be followed by substantial economic growth.

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[1] UNCTAD – The United Nations Conference on Trade and Development.
[2] OEE – Overall Equipment Effectiveness.

However, there are many obstacles to translating these bold predictions into reality. An analysis of publications related to Industry 4.0 and the use of AI (Schwab, 2016; Özdemir, and Hekim, 2018; Caravelli, and Jones, 2018; Effah, and Nuhu, 2017; Howard, 2010; Geissbauer et al., 2016; Schuh, and Anderl, 2017; Greenwald, 2017) allows us to identify the following problem areas: cybersecurity, digital dictatorship, total dependence on the energy system, cybercrime, institutional barriers for using Industry 4.0 and AI, digital culture, unclear economic benefit.

Cybersecurity is important through the fragility and interdependence of digital infrastructure. "Highly integrated systems are vulnerable to systemic risks such as total network collapse in the event of failure of one of its parts, for example, by hacking or Internet viruses that can fully invade integrated systems" (Özdemir, and Hekim, 2018, p. 65). And still, have total dependence Industry 4.0 on the energy system. Problems with the energy system can destroy the infrastructure for operation of Industry 4.0 automatically.

The number of cybercrimes and losses from them are constantly growing. As Editor-in-Chief Cybersecurity Ventures notes, "Cybercrime is the greatest threat to every company in the world, and one of the biggest problems with mankind. The impact on society is reflected in the numbers. In August of 2016, Cybersecurity Ventures predicted that cybercrime will cost the world $ 6 trillion annually by 2021, up from $ 3 trillion in 2015. This represents the greatest transfer of economic wealth in history, risks the incentives for innovation and investment, and will be more profitable than the global trade of all major illegal drugs combined" (Morgan, 2019, p. 2).

Key institutional barriers include "(1) failure to adopt an integrated process approach; (2) failure to completely deinstitutionalize the existing paper-based process flow and physical signatures, and (3) failure to update outdated laws and procedures" (Effah, and Nuhu, 2017, p. 13).

"Lack of digital culture and training is the biggest challenge facing companies" was marked by 50% of the respondents. The second challenge is unclear digital vision (40% of the respondents). And one more significant problem is "unclear economic benefit and digital investments" which named 38% of the respondents (Geissbauer et al., 2016, p. 17).

Using AI to recognize faces and gestures, as well as working with big data leads to the formation of threats for the introduction of digital dictatorship and total control of society (Greenwald, 2017; Greve, 2019).

The presence of these negative factors should lead to a decrease in the effectiveness of introducing industry 4.0 and using AI. However, more research is needed to determine the significance of these problems.

2. Methods

The study is dominated by a descriptive method based on consideration of the economic development of national economies in the context of their introduction of Industry 4.0 and AI. In the process of research, the theoretical developments of scientists who study the processes of digitalization, the introduction of Industry 4.0 and the use of AI are used. As well as in the framework of the study a dialectical method was applied.

The main hypothesis of the study, which is being tested, is: "a high level of implementation of Industry 4.0 and the use of AI should lead to significant economic growth". If the hypothesis is confirmed, then the countries that are in the TOP-10 in terms of the World ICT Development Index and TOP-10 in the World Government Artificial Intelligence Readiness Index must show economic growth rates above the world average. If this is not observed, then economic and institutional constraints for the development of Industry 4.0 and AI have a significant negative impact.

The aim of the article is to verify the above-formulated hypothesis.

3. Results

After the universal and unanimous recognition of the lack of alternatives to the introduction of industry 4.0 and the wide possibilities of using AI, one could expect accelerated growth of the global economy. However, if you look at the dynamics of the global economy (Figure 1), then a noticeable steady decline of growth rates. Since the proclamation of the movement towards Industry 4.0 at the Hanover Fair in 2011 year, the average growth rate of the global economy in 2011-2018 has been 2.84% per year. Even if you look at the average growth rates of the global economy in 2015-2018 when conceptual and theoretical models began to translate into reality more and more, all the same, the average rates will not differ much (2.9% per year). This is almost 2 times lower than the average rate of economic growth half a century ago (in 1961-1968 the average growth rate of the global economy was 5.47%). Thus, the introduction of digital technology has not yet had the same economic effect as the industrialization of the 60s of the last century.
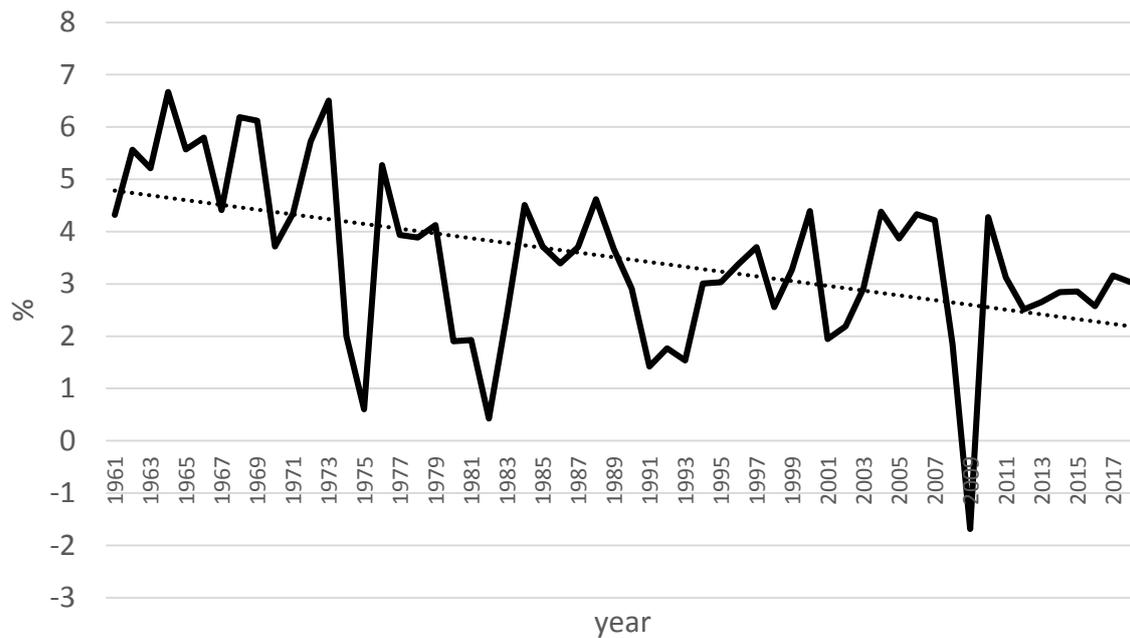
Figure 1. The dynamics of global GDP in period 1961-2018 ("*GDP growth (annual %). World Bank national accounts data, and OECD National Accounts data files*", 2019).

We can the total observation period (1961-2018) divide into two conditional sub-periods: (1) pre-digital period from 1961 to 1990 and (2) digital (1991-2018). "On 6 August 1991, the World Wide Web went live to the world" (Bryant, 2011) and this date we can use as delimiter between these two sub-periods.

Table 1.
Annual GDP growth in digital and per-digital periods

Period	Annual GDP growth rate, %
Pre-digital period: 1961-1990	4,10
1961-1970	5,36
1971-1980	3,83
1981-1990	3,13
Digital period 1991-2018	2,83
1991-2000	2,81
2001-2010	2,83
2011-2018	2,84

Table based on the World Bank's data ("*GDP growth (annual %). World Bank national accounts data, and OECD National Accounts data files*", 2019).

In the pre-digital period, the average annual growth of GDP was 4,1%, in the digital period – only 2,83%. If we divide the periods into decades we can see, that in the pre-digital there was a constant decline in growth from 5,36% per year (in the period 1961-1970) to 3,13% per year (in the period 1981-1990). Decade average growth in the digital period was stable (between 2,81-2,84% per year). These statistics can be interpreted in different ways. From one side digitalization of the global economy cannot provide as high growth as half a century ago. From another side digitalization of the global economy has halted the decline in GDP growth on older technical base. And now the global economy is in an active phase of creative

destruction (Schumpeter's gale), and in the nearest future, we can expect an acceleration in growth.

In any case, it is obvious that the global level does not take into account national specificity, and additional studies are needed in this direction. For this, the dynamics of GDP in countries that are in the TOP-10 the ICT development index and TOP-10 the Government Artificial Intelligence Readiness Index were considered. If Industry 4.0 and AI have a fundamental positive impact on the economy, then the countries that are in the TOP-10 ICT development index and Government Artificial Intelligence Readiness Index should show higher economic growth rates than the world average.

Government Artificial Intelligence Readiness Index includes 4 components: (1) governance, (2) infrastructure and data, (3) skills and education, (4) government and public services (Miller and Stirling, 2019).

Governance consists of privacy laws (UN data protection and privacy legislation worldwide) and forthcoming AI strategy.

Infrastructure and data consists of data availability, government procurement of advanced technology products, data capability (in government).

Skills and education include technology skills, AI startups, innovation capability of private sector.

Government and public services include digital public services, effectiveness of government, importance of ICTs to government vision of the future.

ICT Development Index has three elements: (1) ICT access, (2) ICT use and (3) ICT skills ("ICT Development Index 2017", 2018).

According to the Government Artificial Intelligence Readiness Index (Table 1), GDP in the countries included in the TOP 10 is growing on average more slowly than the global economy. This is true for 2017 and 2018. Moreover, while the growth of the global economy slowed down from 3.16% to 3.03% over the year, the GDP of the countries from the TOP 10 according to the World Government Artificial Intelligence Readiness Index slowed down from 2.41% to 1.93%. And only one country out of 10 showed rates above average. This indicates that the high position of the World Government Artificial Intelligence Readiness Index does not provide accelerated growth rates for the national economy.

Table 2.
Number of countries with GDP growth rate more than in the World Government Artificial Intelligence Readiness Index

#	Country	The Government Artificial Intelligence Readiness Index (2018/2019)	GDP (2017), %	GDP (2018), %
1	Singapore	9,19	1,82	3,14
2	United Kingdom	9,07	2,10	1,40
3	Germany	8,81	2,26	1,43
4	United States of America	8,80	2,22	2,86
5	Finland	8,77	2,16	2,33

Cont. table 2.

6	Sweden	8,67	3,70	2,36
7	Canada	8,67	2,99	1,88
8	France	8,61	2,65	1,72
9	Denmark	8,60	2,26	1,42
10	Japan	8,58	1,93	0,79
	World		3,16	3,03
	Number of countries with GDP growth rate more than in the World		1	1
	Number of countries with GDP growth rate less than in the World		9	9

Table based on the data from World Bank ("GDP growth (annual %). World Bank national accounts data, and OECD National Accounts data files", 2019) and Oxford Insights (Miller and Stirling, 2019).

Regarding the TOP 10 countries in the ICT Development Index, a similar situation is observed (Table 3). Annual GDP growth rates in most of these countries are lower than in the global economy (8 out of 10 in 2017 and 9 out of 10 in 2018).

Table 3.
Number of countries with GDP growth rate more than in the World ICT Development Index

#	Country	IDI* (2017)	GDP (2017), %	GDP (2018), %
1	Iceland	8,98	4,60	4,61
2	Korea (Rep.)	8,85	3,06	2,67
3	Switzerland	8,74	1,62	2,54
4	Denmark	8,71	2,26	1,42
5	United Kingdom	8,65	1,82	1,40
6	Hong Kong, China	8,61	3,84	3,02
7	Netherlands	8,49	2,87	2,67
8	Norway	8,47	1,98	1,45
9	Luxembourg	8,47	1,55	2,60
10	Japan	8,43	1,93	0,79
	World		3,16	3,03
	Number of countries with GDP growth rate more than in the World		2	1
	Number of countries with GDP growth rate less than in the World		8	9

* The World ICT Development Index

Table based on the data from World Bank ("GDP growth (annual %). World Bank national accounts data, and OECD National Accounts data files", 2019) and International Telecommunication Union (ICT Development Index 2017, 2018).

Thus, even rough estimates show that there is no correlation between economic growth (both globally and nationally level) and the processes of ICT technologies development and the willingness of governments to use AI.

Consequently, there are fundamental problems in the cost-effective implementation of industry 4.0 and AI.

Among the problems listed above, it's necessary to add the competition between the introduction of modern digital technologies and the use of cheap labor. For example, Poland actively attracts hundreds of thousands of labor migrants from Ukraine (Jaroszewicz, 2018) and shows rather high growth rates (4.81% in 2017 and 5.14% in 2018). But according

to the ICT Development Index Poland occupies only 49th place from 176 countries, and 27th out of 194 countries in the Government Artificial Intelligence Readiness Index.

Another illustrative example. The USA is more advanced in the use of digital technologies (16th place in the ICT Development Index; 4th position of the Government Artificial Intelligence Readiness Index), but it has lower growth rates of the national economy than China (80th position in the ICT Development Index; 20th position in the Government Artificial Intelligence Readiness Index) and a negative trade balance with China that has persisted in recent decades. So in 2018, China sold in the USA for $419 billion more goods than the United States in China ("Trade in Goods with China", 2019). This ultimately led to ongoing trade wars between the US and China.

These examples confirm the assumption that at the moment, Industry 4.0 and AI have not become key factors of economic growth at the global and national levels.

4. Discussion

The analysis shows that probably Industry 4.0. and AI are not yet the key driver of economic development in this historical period. Rather a high level of economic development leads to a relatively high implementation of technologies related to Industry 4.0 and AI. At the same time, the economic efficiency of Industry 4.0 and AI for individual industries or enterprises is not questioned. This allows us to conclude that individual positive results did not become universal due to objective circumstances and require further research in this direction.

However, always exist the problem of increasing the economic effectiveness of innovations. And a possible solution to this problem (increasing the economic efficiency of digital innovations at the national and global levels) within the framework of the "positive destruction" logic could be another global crisis, which could remove obsolete institutional constraints and redistribute labor resources more efficiently.

5. Summary

Despite the intensified digitalization of the global economy over the past decades, we can see a long-term downward trend in economic growth. At the same time, GDP growth rates for most of the TOP-10 countries according to the ICT Development Index and TOP-10 the Government Artificial Intelligence Readiness Index are lower than the global average rate.

Such trends allow us to conclude that the economic efficiency of the innovation of the fourth industrial revolution does not yet overcome the diminishing efficiency of technologies of previous industrial revolutions.

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