LESSONS LEARNED FROM THE FOURTH INDUSTRIAL REVOLUTION FOR THE GLOBAL ECONOMY

Borce Trenovski
Faculty of Economics – Skopje, Republic of North Macedonia, Borce.Trenovski@eccf.ukim.edu.mk
Gunter Merdzan
Faculty of Economics – Skopje, Republic of North Macedonia, gjunter.merdzan@eccf.ukim.edu.mk

Abstract: The term Industry 4.0 has been used since 2011, but became known to the world public at the World Economic Forum in Davos in 2016. This industrial revolution represents a new phase in human development, as was the case in the previous three industrial revolutions, and in this case the power stems from the growing reach and interaction of a number of new technologies. The process of the Fourth Industrial Revolution is much more than focusing just on aspect of technology. Therefore, in the new era, we need to understand how new technologies are interconnected, how the level of interconnection affects our decisions concerning investment, design, innovation, and so on. In our everyday life, tools such as online systems, artificial intelligence, robotics, 5G technologies, big data and Industry 4.0 are already being permanently imported. If we fail to understand how people and technology communicate with each other, it will be very difficult to work together on investments, policies and joint activities that will have a positive effect on the creation of the future. In the new era in which we live, governments and institutions are reshaping education, health, transport and many other systems. There is a broad consensus among historians of economic thought that certain technologies are important enough to accelerate economic progress. Thus, we have set our research goal in the direction of determining the key lessons learned from the Fourth Industrial Revolution for the Global Economy. In achieving this goal, we first briefly focus on elaborating the concept of the Fourth Industrial Revolution in the context of the speed, breadth, and systemic effect by which it differs from the previous three industrial revolutions. Therefore, we will analyze in more details the expectations from the process of Industry 4.0 in terms of computerization of the processing industry and equipping the production with the highest technology. In the context of the previous one, the three new goals of the Fourth Industrial Revolution will be elaborated: (1) Minimization of the human factor of production and elimination of the omissions of production made by man; (2) Achieving a high level of flexibility in production and creating conditions for product design that will be fulfilled by the specific needs of the costumer, and (3) Intensification of the production process. In addition, lessons learned will be provided regarding the possibilities and threats posed by the Fourth Industrial Revolution, and especially on the problem of inequality as a systemic threat imposed by these processes of digitization and automation. A special part of the research will be focused on the key theories of economic growth that incorporate technology into their growth models: The differences between Harrod-Domar's growth model and Solow's neoclassical growth model and the new growth theories. Finally, in our analysis, we will make attempt to generally identify the key positive and negative effects that the Fourth Industrial Revolution has on the global economy, employment, and enterprise performance.
Keywords: The Fourth Industrial Revolution, new technologies, economic growth, labour productivity

1. INTRODUCTION

The term Industry 4.0 has been used since 2011 but became known to the world at the World Economic Forum in Davos in 2016. The Fourth Industrial Revolution is a way of describing a series of ongoing and upcoming transformations in the systems that are common to us and that surround us. This industrial revolution represents a new phase in human development, as it was in the case of the previous three industrial revolutions, and here the power stems from the growing accessibility and interaction of a range of fantastic new technologies. However, we should emphasize that the new technologies, which are the locomotive of the Fourth Industrial Revolution, are developed on the basis of the acquired knowledge and established systems from the previous industrial revolutions, and especially using the digital possibilities left by the Third Industrial Revolution (Schwab & Davis, 2018).

But the process of the Fourth Industrial Revolution is much more than a focus on the changes we see on each side, just in terms of technology. Yes, thanks to technology, we are creating more abundant world, one where we get more and more output from fewer inputs like raw materials, capital, and labour. In the years to come we will continue to benefit in the form of things that are relatively easy to measure, such as bigger productivity, and things that are less susceptible to metrics, such as the boost we get from free digital goods. But bounty doesn't mean simply more cheap consumer goods and empty calories. According Brynjolffson and McAfee (2014), it means simultaneously more choice, greater variety, and higher quality in many areas of our lives; it means heart surgeries performed without cracking the sternum and opening the chest cavity; it means constant access to the world's best

teachers combined with personalized self-assessments that led students know how well they're mastering the material; it means that households have to spend less of their total budget over time on groceries, cars, clothing, and utilities; it means returning hearing to the deaf, and sight to the blind; it means less need to work doing boring, repetitive tasks and more opportunity for creative and interactive work.

Therefore, in the new era, we need to understand how new technologies are interconnected, and how their connectivity affects our investment decisions, design, innovation etc. Instruments such as online systems, artificial intelligence, robotics, 5G-technologies, big data and Industry 4.0 have already been permanently introduced in our lives. Discussions have already started about Industry 5.0. If we fail to understand how people and technologies communicate with each other, it will be very difficult, though not impossible, to work together on investments, policies, and join activities that will have a positive impact on creating the future.

Schwab and Nicholas Davis (2018), present the process of the Fourth Industrial Revolution with a special emphasis on new technologies as a great opportunity to discover different ways to positively influence as many people, families, organizations, communities, and others as possible, by influencing and directing the systems that surround our environment and shape our lives.

In the new era, we live in we are witnessing profound changes in all sectors, new business models are emerging, existing organizations are degrading, production, consumption, transport, and supply systems are being reshaped. On the social front, the paradigm is changing, which refers to the way we work and communicate, the way we express ourselves, inform each other, and have fun. Governments and institutions are also reshaping education, health, transportation, and many other systems. We can say that our lives, ways of working, and relationships are radically changing!

2. HISTORICAL CONTEXT

Anthropologist Ian Morris, in his book Why the West Rules - For Now? (2010), has done hard work to measure the phenomenon of „social development" (the ability of a group or individual to master his physical and intellectual environment to realize the goals). The results of Morris's analysis show that no change in human history has made, in relative terms, as radical changes as the steam engine and mechanical production of the First Industrial Revolution (Industry 1.0).

So, growth and development move together with mechanical production through the construction of railways and the steam engine as products of the First Industrial Revolution which lasted from 1760 to 1840. This industrial revolution in that period managed to transform all industries and led to the birth of many new industries, from various machine tools to steel products and from the steam engine to the railways. These new technologies have made changes in collaboration and competition. This, in turn, developed completely new systems for generation value, exchange, and distribution and transformed all sectors, from agriculture to manufacturing, from communication to transport, and so on. On the one hand, it contributed to the development of colonialism and environmental degradation, and on the other hand, it managed to make the world richer. According to Crafts (1987), before 1750 even the richest countries - Britain, France, Prussia, North America, and their colonies - grew at an average annual growth rate of approximately 0,2%, which was extremely unstable. Inequality was at a higher level than today, and per capita income was at the level that today would belong to the group of extreme poverty.

The Second Industrial Revolution (Industry 2.0) brought to light serial production backed by electricity and the assembly line. Radio, telephone, television, home appliances, and electric lighting have all shown the transformative power of electricity. The internal combustion engine enabled the production of automobiles and aircraft and boosted the ecosystems of these sectors - manufacturing, assembly of parts, and highway infrastructure. There have also been remarkable developments in the field of chemistry: the world has become acquainted with thermoset plastics and many other materials and new processes (for example, the Haber-Bosch process, which initiated the Green Revolution in the 1950s as a result of the production of cheap nitrogen fertilizers through the synthesis of ammonia, etc.) (Schwab & Davis, 2018). That is, the Second Industrial Revolution, from improvements in health care to international air travel, heralded the advent of the modern world as we know it today.

Meanwhile, the Third Industrial (Industry 3.0) Revolution began in the 1960s. That computer or digital revolution developed through semiconductors, computer networks, and the Internet. But, as with the previous two, this industrial revolution was not the result of new digital technologies but developed through the integration of these new technologies into our economic and social systems and their transformation. The ability to digitally store, process, and transmit information has transformed almost all sectors and radically changed the work habits and social lives of billions of people. If we talk at least about the developed countries, the three industrial revolutions have caused a huge increase in wealth and opportunities. Just to illustrate, McCloskey (2016) concludes that today's Organization for Economic Co-operation and Development (OECD) countries, or countries where one-sixth of the world's population lives, today have 30 or 100 times larger per capita income compared to the 19th century.

Now, on the other hand, we are experiencing the Fourth Industrial Revolution or the Second Machine Age, which differs from the previous ones on three grounds: speed, breadth, and system effect. It is developing on the foundations laid by the previous industrial revolution. But it is not just about smart and connected machines and systems, it has a much wider scope. There are simultaneous jumps in multiple areas; from sequencing whole genomes, nanotechnologies, renewable energies to quantum techniques. The main difference of this revolution from the previous three will be the possibility of merging these technologies and their interaction across physical, digital, and biological fields (Um, 2019).

3. THE OPPORTUNITIES AND THREATS OF THE FOURTH INDUSTRIAL REVOLUTION

Under ideal conditions, the Fourth Industrial Revolution offers the opportunity to continue the upward rise in human development for those who have managed to reap the benefits of the previous three industrial revolutions and also to develop and enrich the lives of those deprived of the benefits that offer entire technological systems, private and public institutions. If the technologies of the Fourth Industrial Revolution are integrated with appropriate institutions, standards, and norms, people around the world on the one hand will enjoy greater freedom, better health, better education, and more opportunities for the life they desire and value, and on the other hand, will not suffer from insecurity and economic uncertainty.

Contrary to the black scenario predicted by the Luddites, and the dangers and threats that the world would face in the future due to technological progress, such as those highlighted by Bill Joy in his famous article „Why the future does not need of us“ (Why the Future Doesn't Nees Us) written back in 2000 in Wired Magazine; a group of scientists and engineers predict a far more optimistic future in which technological innovation - and the ability to integrate it into our daily lives - will become the basis of social and economic development. For example, we were inspired to work on this topic when we read Klaus Schwab's book (discussed earlier) published 16 years after Joy's article, which is an equally passionate treatise but focuses more on the transformative power of new technologies in a positive sense.

We will first talk about the positive aspects of growing technologies. Quantum Information Technology, promising huge efficiency gains in many different areas, such as logistics and drug discovery, offers incredible advances in methods for modeling and optimizing complex systems. The use of blockchain technology, as was and still is the case with bitcoin and other types of digital money, significantly reduces the cost of coordination between different parties. This technology can become a driving force for the flow of huge amounts of value through digital products and services and make all markets accessible to anyone with an internet connection, of course, if it overcomes problems with the authorities and secures digital identities using cutting-edge techniques of encryption. Virtual and Augmented Reality offer new channels to experience the world around us, it also speeds up and enriches the process of acquiring skills and applying them anytime, anywhere. Advanced Materials can revolutionize the use of civilian and military drones, the supply of electricity to poor communities, and transportation systems (Schwab & Davis, 2018).

But all these benefits depend on the technological progress and the development of the institutions in each country. It is very uncertain how and when these benefits would be realized and which countries, companies, or individuals would enjoy them. The Fourth Industrial Revolution creates new challenges, opportunities, but also threats to the world at a time of growing inequality, social tensions, and political divisions, as well as vulnerable societies increasingly exposed to threats from economic uncertainty and natural disasters. However, according to Klaus Schwab and Nicholas Davis, the experiences of previous industrial revolutions indicate that to fully realize the benefits of new technologies, the world will have to face and solve the three challenges imposed by previous revolutions. and from the latter. Those three challenges of the new era are the following (Schwab & Davis, 2018)

- The first challenge concerns the growing inequalities in income distribution around the world. It is necessary to ensure a fair distribution of the benefits of the Fourth Industrial Revolution. The wealth and prosperity gained from previous industrial revolutions were unevenly distributed and this practice continues. As Thomas Piquetti points out in his famous book Capital in the Twenty-First Century, inequalities between countries have been significantly reduced since the 1970s due to the rise of nations in fast-growing economies, but on the other hand increase inequalities within, in each country. There are several reasons why people are sometimes deprived of enjoying the benefits of systems. For example, the unavailability of the system for economic or other reasons; public or secret bias; the operation of institutions that often tend to monopolize profits or concentrate wealth and opportunities in certain locations (Acemoglu & Robinson, 2012)
- The second challenge is about managing externalities in terms of the risks and harms announced by the Fourth Industrial Revolution. During the previous industrial revolutions, very little effort was made to protect vulnerable societies, the natural environment, and future generations from the unintended

consequences, the cost of change, the side effects, or the consequences of deliberate misuse of opportunities. Also, given the uncertainty of the long-term effects of the technologies of the Fourth Industrial Revolution on complex social and environmental systems and their power, the risks in terms of externalities and adverse outcomes are high. For example, compare the threats of 20th and 21st-century technology. The technologies that underlie weapons of mass destruction - nuclear, biological, and chemical - are powerful, and weapons pose a huge threat. But building nuclear weapons requires, at least for a time, access to scarce - indeed, effectively inaccessible - raw materials and highly protected information; biological and chemical weapons programs also require large-scale activities. While the technologies of the 21st century - genetics, nanotechnology, and robotics - are so powerful that they can create new classes of accidents and abuses. The most dangerous thing is that, for the first time, these threats are widely available to individuals or small groups. They will not require large plants or rare raw materials. Only knowledge will allow access to them (Joy, 2000). Many more risks can also be enumerated, ranging from the most formidable, geoengineering initiatives that can cause sudden and irreversible damage to the biosphere; quantum computing under some scenarios can create significant privacy and security risks by deactivating an existing encryption system; until the widespread use of autonomous vehicles which is expected to block traffic even more in crowded cities and so on.

- The third challenge, on the other hand, is to ensure that the Fourth Industrial Revolution is man-made and directed. It is necessary to nurture human values because of themselves, and not to refer only to measurements and quantifications from a financial point of view. Focusing on the person will mean empowering people instead of limiting them. This challenge is very important, precisely because the technologies of the Fourth Industrial Revolution differ from those of the previous Industrial Revolutions. They can access hitherto untouched parts of our brains by reading our thoughts or shaping our behavior. They can make assessments, make decisions by processing data that no individual can process in ways that are completely unknown to most people. Also, these technologies are spreading through digital networks much faster than the previous stages of technological development and will continue to spread with such incredible speed in the future.

4. DEEP AND SYSTEMIC CHANGES

The scale of change in the new era of technology and digitization explains why transformation and innovation are so urgent. The speed of innovation in terms of their development and spread is greater than any other time. Today's platform-based companies such as Alibaba, Airbnb, Uber, were relatively unknown only a few years ago. The ubiquitous iPhone was first launched in 2007. While in 2019, there were 5,112 billion unique mobile phone users (We Are Social & Hootsuite, 2019). In 2010, Google launched its first autonomous vehicle on the streets. Such vehicles could soon become a widespread reality on the roads.

But, as we said before, it is not only about speed, but also economies of scale are at an astonishing level. At the same time, digitization means automation, which means that there is no need to reduce yields in terms of volume or at least a much lower intensity. To confirm this, we will cite an example from Schwab (2016), which uses it to explain the changes that follow. Compare Detroit from 1990 (one of the major industrial centers at the time) with Silicon Valley from 2014. In 1990 in Detroit, the combined market value of the three largest companies was $ 36 billion, total revenue $ 250 billion, and about 1,2 million workers were employed. While in Silicon Valley in 2014 the combined market value of the three largest companies was $ 1,09 trillion (about 28 times more), it had approximately the same level of inflows of $ 247 billion, but all these results were reached 10 times fewer workers (137.000) compared to Detroit in 1990.

The fact that today every unit of wealth is created with far fewer workers compared to 15 or 20 years ago, and this is possible because digital enterprises have marginal costs close to zero. Also, another reality of this age is, in fact, the production of 'information goods', which implies virtually zero costs for storage, transport, and replication. For example, companies like Instagram, WhatsApp, or other platform-based companies do not need significant funding at the outset. So with the Fourth Industrial Revolution, the roles of capital and economies of scale are changing. In summary, all these developments increase yields in terms of volume and cause changes in all systems.

According to Schwab (2016), the Fourth Industrial Revolution, in addition to its speed and prevalence, is unique in promoting the growing harmonization and integration of many different disciplines and discoveries. Material innovations that result from the interdependence between different technologies are no longer considered science fiction. Today, for example, digital production technologies can easily communicate with the biological world. Some designers and architects have already begun to combine computer design (computational design), additive manufacturing, materials engineering, and synthetic biology with pioneering systems involving the interaction of microorganisms, our bodies, the products we consume, and even the buildings we live in. We can say that through

such technologies and their combination and integration, objects are produced that are continuously changeable and adaptable.

In their book The Second Machine Age, Bringolfson and McAfee argue that computers are so proficient that it is virtually impossible to predict what applications we will be able to use. Artificial intelligence, virtual assistants, drones, autonomous vehicles are all around us and transforming our lives. Artificial intelligence has made impressive progress as a result of the exponential increase in computing power and the consequent availability of vast amounts of data, software used to discover new drugs, and algorithms that anticipate our cultural interests. These algorithms learn based on the data we leave in the digital world as „bread crumbs" (Schwab, 2016). As Yuval Noah Harari wrote in his book Homo Deus, the only thing the algorithms behind our social media profiles need is just 300 likes. After 300 likes, the algorithms know us more than ourselves and can make our choices instead of us (Harari, 2017). According to MIT's Max Tegmark (2017), this results in new types of machine learning and automatic recognition that allow intelligent robots and computers to self-program and find optimal solutions to the original principles as shown in the movies, „Transcendence" by director Wally Pfister (2014) and „Ex Machina" directed by Alex Garland (2015).

5. THE IMPACT OF NEW TECHNOLOGIES ON GLOBAL ECONOMIC GROWTH

Long-term differences in growth rates have far-reaching consequences for economies when they emerge. If two economies start with equal GDP per capita, but one grows at a 4% higher rate, it will become almost 5 times richer in 40 years. The more modest 2% advantage translates into twice the national income in 40 years. Why is this growth important in the long run? Because long-term GDP growth improves people's economic and social performance and is key to the well-being of societies (Fiti, 2010).

In terms of theories of economic growth after the second half of the 20th century, four influential theories of economic growth can be distinguished: (1) The neo-Keynesian Harrod-Domar model; (2) Robert Solow's neoclassical model; (3) The endogenous model of economic growth of Romer and Lucas and (4) Institutionalist theories. In the Harrod-Domar model, savings and investments were the conditions for economic growth; in the Solow model, economic growth depended on investment in labour, capital, and total factor productivity, which depended most on technological change. While economic growth, according to Romer, is mainly determined by technological change and innovation, i.e. they are involved in long-term economic growth and companies can influence them (Petreski, 2000).

According to the Solow-Swan model, an increase in the accumulation of capital and labour increases the rate of economic growth, but only temporarily due to the action of declining yields on the volume and stops once the steady-state is reached and when resources will be exploited in one country, the growth rate of the economy can be increased only through innovations and improvements in technology (Akande, Maryam, Loffredo, & Curcio, 2017).

The model tries to measure the exogenous increase of total factor productivity (TFP), or multifactor productivity for a certain period through the so-called Solow Residual. The growth in MFPs is often entirely attributed to technological advances but also includes any lasting efficiency improvements through which factors of production combine over time. Solow residual is an unexplained change in output growth after calculating the effect of capital accumulation and labour (Solow, 1987).

But as noted by Paul Romer (1990), winner of the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel (Nobel Prize in Economics) for 2018, the dominant growth theory of the 1980s - The Model of Solow, who won the Nobel Prize in Economics in 1987 - can explain many features of economic growth, but not large and persistent differences in growth rates. Solow's model predicts that poorer countries should grow faster and catch up with richer ones fairly quickly. In the model, an economy can grow by accumulating physical capital, for example, machinery or infrastructure, but capital-driven growth must slow in the long run; for any technology in question, adding more capital contributes to the less and less additional output. To enable sustained long-term growth (and growth gaps) in the model, the assumption should be that over time labour becomes more productive due to technological advances, albeit at different rates in each country. Because in Solow's model the changes in technology simply arise exogenously from a „black box", that model fails to explain these trends.

Romer's greatest achievement was that he was able to open that „black box" and show how ideas for new goods and services - produced by new technologies - could be created in a market economy. He also showed how such endogenous technological changes can shape growth and what policies are necessary for these processes to work well. Romer's contribution has had a major impact on economic growth. His theoretical explanation laid the groundwork for research into endogenous growth and new growth theories and models (The Royal Swedish Academy of Sciences, 2018a).

As stated above, in his approach to understanding economic growth for decades and centuries, Solow assumed an exogenous stable path to technology — the ultimate source of economic growth and prosperity. In this sense, he did

not address the very root of long-term growth. Romer, instead, focused on the essence - how market economies can develop new technologies through profit-oriented and research and development (R&D) efforts (The Royal Swedish Academy of Sciences, 2018b). His solution laid the foundations for what is now widely referred to as the theory of endogenous growth. This theory argues that „ideas" are key to economic growth and considers the preconditions for the production of ideas.

New ideas, Romer argues, are very different from most economic goods in that they are uncompetitive: one person using one idea does not prevent others from using the same idea. But he emphasizes another aspect of ideas: the extent to which they are exclusive. Even if the idea can be used by two companies at the same time, it may be likely that one of them will be excluded from this use, either by regulation/patent law or by technical protection (for example, through encryption). Exclusivity is key to ideas being produced in the marketplace, Romer said, and not all ideas allow it. For example, some forms of basic research do not fall into this category and should therefore be best produced by universities or other government-supported institutions to do so.

Next, according to Romer, the production of ideas usually entails increasing yields of volume, with high initial draft costs, and low, probably constant marginal costs for its further replication. In this way, Romer pointed out that ideas and market power go hand in hand: market power is a typical way to guarantee higher prices than marginal costs, allowing firms to offset fixed costs on drafts. In this sense, monopoly profit is the engine of market R&D. However, the underlying competitiveness of the product idea can generate potential spillover effects - positive externalities. Because the market solution involves a degree of monopoly power, it usually generates an inefficient outcome. To sum up, unregulated markets will make technological changes, but they will not do so effectively. This points to the potentially important role of economic policy, not only in every country but all over the world.

6. CONCLUSION

The use of the word „revolution" in conjunction with „industry" has now become part of our cultural heritage. Our industrial achievements are so monumental and numerous that the impact can hardly be estimated. We live every day using various appliances and instruments produced by different industrial revolutions, such as washing machines and vacuum cleaners, trains and cars to take us where we want. The term „industrial revolution" refers to the change that is taking place in the technological, economic, and social systems of industry, as is happening now with the Fourth Industrial Revolution and the new technologies mentioned above.

The WEF Conference in January 2016 clarified to global business leaders, heads of state, public intellectuals, and NGOs the process of the new industrial revolution. So, to speak, 2016 was the year of the announcement of the beginning of the Fourth Industrial Revolution as a replacement for the Third Industrial Revolution that appeared about four decades ago.

Many scientists offer their thoughts, interpretations, and recipes for what exactly the world should expect and how it should react. Some argue that the Fourth Industrial Revolution and future innovations do not at all imply such growth potential as we have experienced in the past, with computers, for example. Others argue that innovation and growth with technology, artificial intelligence, virtual and augmented reality, and so on. in any case they will be stronger than the previous industrial revolution. Self-driving cars start moving everywhere on the roads, various household appliances equipped with AI, for example, refrigerators, TVs, smartphones, etc. are increasing rapidly. As artificial intelligence in some fields surpasses humans (as is the case with computer games), we can say that the signs of change are beginning to materialize.

„General purpose technologies" are those that have the power to change the industry. The steam engine and electricity of the First and Second Industrial Revolutions are examples of such disruptive technologies. Traditional businesses and services in the First and Second Industrial Revolutions based on electricity were disrupted by the integration of digital and telecommunications technologies of the Third Industrial Revolution. In the Fourth and Next, the Fifth Industrial Revolution, the global economy will face unprecedented changes with the advent of disruptive technologies, such as artificial intelligence, the Internet of Things, advanced robotics, augmented and virtual reality, 3D printers, and more. These technologies are expected to bring about fundamental changes in production, distribution, and consumption while transforming current modes of trade and investment between countries.

In the current year, we are experiencing how the global economy has faced the most challenging crisis since the Second World War, caused by Covid-19 disease. The new type of coronavirus has tested the functioning of all known mechanisms. The only solution for the individual economies and world as a whole to deal with these problems is to accept the challenge of the new digital era, as it has been in the past. In this new era, the changes are quite deep that, from the perspective of human history, there has never been a period of greater hope or greater danger. All economies both developed, emerging and developing countries, will have to accept and apply the

changes that occur in the ways of conducting diplomacy, education, health, the functioning of companies and in many other areas.

REFERENCES

Acemoglu, D., & Robinson, J. A. (2012). *Why Nations Fail: The Origins of Power, Prosperity and Poverty* (1st ed.). New York: Crown.

Akande, E., Maryam, A., Loffredo, M., & Curcio, S. (2017). *The Role of ICT in Labor Productivity.* Torino: Università degli studi di torino.

Brynjolfsson, E., & McAfee, A. (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies.* New York: W. W. Norton & Company, Inc.

Crafts, N. (1987). Long-Term Unemployment in Britain in the 1930s. *The Economic History Review, 40*(3), 418-432.

Fiti, T. (2010). *Economics* (3rd ed.). Skopje: Faculty of Economics - Skopje.

Harari, Y. N. (2017). *Homo Deus: A Brief History of Tomorrow.* New York: Harper.

Joy, B. (2000). Why the Future Doesn't Need Us. New York: Wired Magazine. Преземено June 22, 2020 од https://www.wired.com/2000/04/joy-2/

McCloskey, D. N. (2016). *Bourgeois Equality: How Ideas, Not Capital or Institutions, Enriched the World* (1st изд.). Chicago: University of Chicago Press.

Morris, I. (2010). *Why the West Rules - For Now: The Patterns of History, and What They Reveal About the Future.* New York: Farrar, Straus and Giroux.

Petreski, G. (2000). *Economic Growth and Development* (1st ed.). Skopje: Faculty of Economics - Skopje.

Romer, P. (1990). Endogenous Technological Change. *Journal of Political Economy, 98*(5), 71-102.

Schwab, K. (2016). *The Fourth Industrial Revolution* (1st изд.). Cologny/Geneva, Switzerland: World Economic Forum.

Schwab, K., & Davis, N. (2018). *Shaping the Fourth Industrial Revolution* (1st изд.). Cologny/Geneva, Switzerland: World Economic Forum.

Solow, R. (1987). We'd better watch out. *The New York Times Book Review*.

Tegmark, M. (2017). *Life 3.0.* Vintage Books.

The Royal Swedish Academy of Sciences. (2018a). *Integrating Nature and Knowledge into Economics.* Stockholm.

The Royal Swedish Academy of Sciences. (2018b). *Economic Growth, Technological Change, and Climate Change.* Stockholm.

Um, J.-S. (2019). Introduction to the Fourth industrial Revolution. Во *Drones as Cyber-Physical Systems.* Singapore: Springer.

We Are Social & Hootsuite. (2019). *Digital 2019: Essential Insights into How People Araund the World Use the Internet, Mobile Devices, Social Media, and E-Commerce.* New York. Преземено July 3, 2020 од https://wearesocial.com/global-digital-report-2019