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The global economy in technological transformation conditions: A review of modern trends

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ABSTRACT

Despite the neo-industrial marathon of most developed countries, Russia, China, India, and other developing countries will determine the trend of the world economy in this century. Exogenous factors influence the development of national economic systems, which are particularly significant in the context of the intensification of globalization processes. This study identifies and analyzes the most important new trends in the world economy and investigates the effect of these key trends for the economy and society. The authors emphasize the importance of fifth-generation networks as a digital breakthrough for the connectivity of devices. The authors then investigate the effect of the development of artificial intelligence as one of the key elements of the new technological revolution. Following this, the factors and preconditions behind the emergence of new trends in the world economy are presented, and these trends' interrelationship and impact on the future of the world economy as part of neo-industrialization are investigated. To this end, a system analysis and economic and statistical methods are used to identify new trends. The identified trends shape the strategy of the economic development of many countries, including Russia, which is highly exposed to external factors.

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Introduction

In the 21st century, although the wealth of nations is greater than ever before, the turbulence and instability of the world order is also at its highest. International conflicts have aggravated uncertainty in the global economy and financial markets. The nature of uncertainty and instability has been investigated in various existing studies and cannot be understood without further analysis of new trends in the global economy (Batt, 2018; Dorsser & Taneja, 2020; Matyushok & Krasavina, 2016a, 2016b;

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Walker et al., 2010). The U.S. makes every effort to modernize a number of macroeconomic systems after the Second World War. In their study, Adecola and Sergi (2008) emphasized that investment in information technology (IT) has increased productivity in U.S. labor markets. In fact, noticeable investment flows in this sector allowed American firms to record high productivity growth rates and accelerate the country's economic growth to very high rates. The U.S. is trying to preserve a globalization model based on Americentrism, to not only keep the prosperity of the country intact but also maintain its global dominance.

Theoretical framework

The authors specify six trends within the STEEEP categories proposed by Watson (2013):

Societal – This is not covered by the authors.

Technological: The third trend is neo-industrialization, which is an objective process of the newest industrial model formation based on high-technology structures.

The fourth trend, which is the 'digitalization' of the world of people and the world of things, involves the creation of a 'smart' economy (new technology trends).

Environmental: The sixth trend is the shift from a raw material market to services market and technologies.

Economic: The second trend is the growth of uncertainty in financial markets, capital outflow from developing markets to developed countries, and formation of new markets.

Energy: The fifth trend is the end of the era of hydrocarbon fuel, change in the structure of energy balances, and formation of new energy trends.

(Geo) Political: The first trend is the relocation of the center of business activities from the most developed countries to developing countries and markets, such as China, Brazil, and India, while maintaining the leadership of the U.S. and other highly developed countries in the scientific-technical sphere and world finance.

Method

The authors employ empirical observations, theoretical explanations within literature reviews, and statistical analysis, as well as the Level-3 uncertainty as described by Walker et al. (2010). They then integrate the three-layered foresight framework described by Dorsser and Taneja (2020) to propose six trends.

The moving of the business activity center from the most developed countries to developing countries and markets, such as China, Brazil, India and others, while maintaining the leadership of the U.S. and other highly developed countries ('most developed countries') in scientific and technological fields and in world finance. Aslam and Azhar (2013) highlighted the challenges presented by the globalization process to developing countries in the areas of trade and industry.

The increasing uncertainty in financial markets. A general overview of the impact of financial globalization on the financial sector, with a view to identifying the sources of strength and the potential vulnerabilities was given by Chan-Lau (2008). He

focused on the benefits and risks of financial stability that are associated with changes in financial markets, globalization, and the role played by other important players in the global financial system. The author also examines the risks to financial stability that arise from the regulatory regime. Cordey and Rossi (2010) revealed the importance of 'global time' in order to avoid instability in the entire financial system and its negative consequences for the global system. The authors proposed a new time measurement system. Adopting such a system improves the governance and supervision of an ever-increasing number of cross-country and cross-currency transactions, in both product and financial markets, thus contributing to ensuring that systemic risks are less likely to occur.

The outflow of capital from emerging markets to developed countries. Mertens (2018) provided figures on the volatility of economic growth in poor and rich countries and analyzes it in his study. Furthermore, he examined the relationship between economic instability and insecurity at the global level. Gabriel and Al-Kwifi (2012) considered a global perspective behind transnational corporations from developing countries, especially corporations moving to developed countries. Findings identify three main factors that influence the observable fact of transnational corporations from developing countries: globalization, competition, and strategic choices concerning future growth.

The development of new markets. Sharma and Thaker (2015) studied developed markets that showed inefficiency in terms of monthly returns, which is contrary to the conventional perception that developed markets are efficient in comparison to emerging markets owing to their long existence, better maturity, depth, and technological development. Neo-industrialization is an objective process of the formation of a new model of industry based on high-technology structures (Biryukov & Romanenko, 2017). Komninos and Nicos (2016) state that "Digitalization" of the world of people and the creation of "smart" economy and "smart" cities are processes with ICT in civil societies. According to Berezin et al. (2019) smart cities boost economic growth around the world by changing to the smart environment, smart economy, smart technologies, smart human capital, smart infrastructure, and smart governance to improve economic growth and better use limited resources. Selim et al. (2018) showed that the concept of smart infrastructure was derived from the idea of the smart city described as a comprehensive system with different elements such as people, governance, environment, economy, mobility, and living conditions of a given geographical space with efficient Information and communications technology (ICT) that promote smart sustainable environment. The 'smart' city concept will boost economic development within the Eurasian Economic Union (EAEU) (Andronova et al., 2018). Moreover, Cosgrave et al. (2014) emphasized that technology-driven developments (e.g., ICT) are affecting all cities across the globe, 'irrespective of whether they choose to invest in or incorporate the smart city concept into their governance agenda'.

The end of the fossil fuel era, changes in the energy structure balance, and the formation of new energy trends. Utama et al. (2014) identified that developed countries are not the major consumers of oil and other major fossil fuels anymore, and today China, India, Brazil, and South East Asian nations lead the increased energy demand in line with their economic growth and bulging populations. The ASEAN nations estimate their future energy demands (including fossil fuels) by using a bottom-up

approach and various variables such as economic development and population trends by referencing developed countries, the country's landscape, and technological efficiency. Gomonov et al. (2017) emphasized that modern development of the energy industry is focused on the development of a highly efficient and safe infrastructure with the use of modern and efficient equipment with intelligent power systems, and on the local implementation of renewable energy generation. The transition from power systems burning fossil fuels to renewable energy sources can produce much-needed benefits, ranging from less air pollution to more energy security, or broader access to energy, up to the establishment of a new economic paradigm, the so-called 'low-carbon economy' (Moroni et al., 2016).

The transition from raw material markets to service and technologies markets. Pothen (2015) analyzed the drivers of raw material consumption, which measures the extraction of materials necessary to produce a country's final demand. In addition, he concluded that falling material intensities in extractive industries, as well as changes in production and trade patterns, decelerated the growth of raw material consumption.

The current trends in the development of the world economy are characterized by the rapid intensification of globalization processes, which are gaining momentum from year to year. Development-related questions have been raised periodically for over 50 years, starting from an overview of the links between the profit-oriented trends of the globalization process and the non-profit aims pursued by the 'development cooperation world' (Bolay, 2004). The globalization of the world economy is a complex multidimensional process that stimulates more and more the interest of scientists and researchers to study its essence. Mathe and Dagi (2014) summarized the latest phase of an ongoing research program regarding the strategic management of globalization in the service sector. They focused on the role of technology in the international expansion of industries.

St. Marie et al. (2008) uncovered important links between globalization, economic development, and trade. It is necessary to identify current trends in the global economy in the context of technological (Konlechner et al., 2018) and digital transformation (Kaivo-Oja et al., 2017) to deepen research in this area.

To some extent, all of the trends observed play a strategically important role in the formation of sustainable development and economic growth of many countries, including both developed countries and developing countries, as well as Russia. According to Berezin et al. (2018), elements such as state, society, people, economy, information technologies, and ecology should be included in a country's system of sustainable development. These elements combine an institution such as a Public-Private Partnerships (PPP). In this regard, in order to improve the quality of life of the general society, it is necessary to develop a new and effective scientific management tool for the most accurate forecasting of possible negative risk events and their minimization in the process of implementing innovative PPP projects.

Results

The first trend emerged from the end of the last century and is shown in relocating the center of business activities from the most developed countries to developing countries

Table 1. Dynamics of real GDP growth, annual percent change.

Country	2013	2014	2015	2016	2017	2018	2019	2020
Developing countries, in total, including:	5.1	4.7	4.3	4.6	4.8	4.5	4.4	4.8
Brazil	3.0	0.5	−3.5	−3.3	1.1	1.1	2.1	2.5
India	6.4	7.4	8.0	8.2	7.2	7.1	7.3	7.5
China	7.8	7.3	6.9	6.7	6.8	6.6	6.3	6.1
Philippines	2.6	3.6	0.7	1.3	2.9	5.2	3.8	3.3
Russian Federation	1.8	0.7	−2.5	0.3	1.6	2.3	1.6	1.7
Developed countries, in total, including:	1.4	2.1	2.3	1.7	2.4	2.2	1.8	1.7
The United States of America	1.8	2.5	2.9	1.6	2.2	2.9	2.3	1.6
Germany	0.6	2.2	1.5	2.2	2.5	1.5	0.8	1.4
France	0.6	1.0	1.1	1.2	2.2	1.5	1.3	1.4

Source: Calculated and made by authors according to: IMF World Economic Outlook (WEO), April 2019a (IMF, 2019a, 2019b).

and markets, such as China, Brazil, and India, while keeping the leadership of the U.S. and other developed countries in the scientific-technical and world finance sphere.

The share of developed countries in world gross domestic product (GDP) based on PPP was 57% in 2000, 50% in 2007, only 40% in 2018 (according to the IMF data),[1] and it is expected to be 38% in 2022 (according to the IMF forecast figures). The U.S. is losing its leadership in the world economy. Its share in world GDP was 31% in 2000 but only 24% in 2018. The GDP of the E7,[2] which now includes Russia, China, India, Brazil, Turkey, Indonesia, and Mexico, exceeded the PPP exchange rate of the old G7 countries (the U.S., Canada, United Kingdom, Germany, Italy, and Japan) in 2014. The share of China in world GDP calculated by PPP began to exceed the same indicator of the U.S. from 2014, increasing the gap year by year.[3]

According to IMF data, the economies of developing countries will rise at an increased rate. The growth rate was 4.5% in 2018 and is expected to be 4.8% in 2020. This indicator is significantly lower for most developed countries: 2.2% in 2018 and 1.7% in 2020 (Table 1). Rapid economic growth, as well as population growth and increasing income levels, has turned emerging markets into the basis for business development strategies and improvement.

As a result, the economic impact has shifted to the East and the developing countries' organizations with the highest profits have started investing in the most modern technologies, surpassing developed countries at times, thus creating severe competition to the economies of the West.

The current slowdown in economic growth of developing markets is connected to not only Brazil, but also China, where economic growth is expected to decrease to 6%–7% in 2014–2020 compared to 8%–9% in 2008–2013, and with Russia, which is now considered the country with a transition economy (Yusupova, 2017). China remained the fastest growing country among major developing countries until 2013, at which point the leadership in the expansion factor passed to India (Figure 1).

China remains a colossal growing market despite the risks associated with the rebalancing of the economy. With a population of 1.4 billion people, China has the largest reserves of labor. Thus, this country presents an enormous consumer market. According to the World Bank and the IMF, China overtook the U.S. in terms of GDP at PPP (respectively, $17.1 and $16.6 trillion in 2014, and $21.2 and $17.7 trillion in 2017) (World Bank, 2019). Thanks to the growth of the consumer market, the GDP per capita at PPP increased from $5 thousand in 2005 to $10.9 thousand in

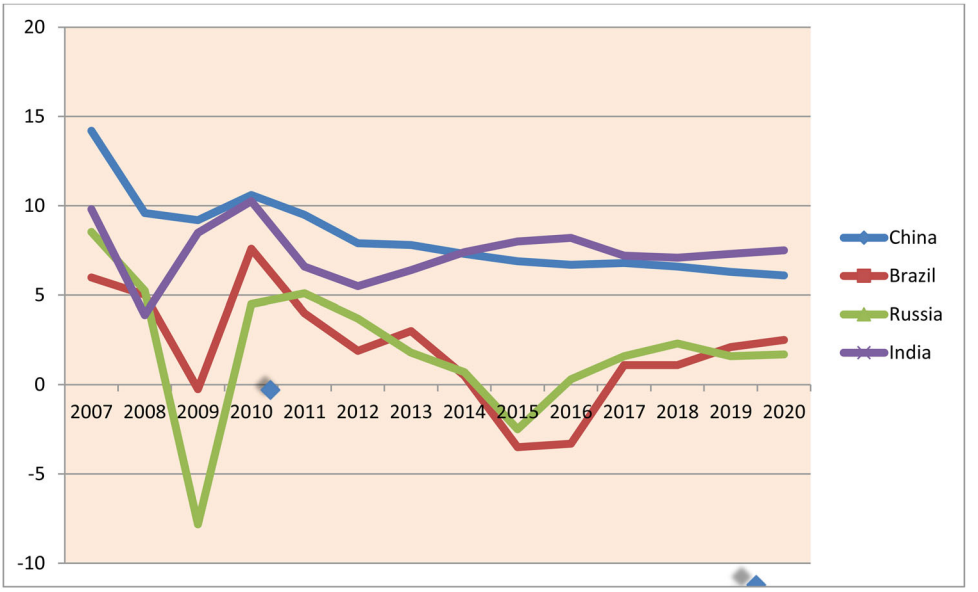

Figure 1. Economic growth in the major developing countries, annual percent change. *Source*: calculated by authors according to: International Monetary Fund, Principal Global Indicators (IWF, 2019a, 2019b).

2014, it is estimated that, by 2020, it will reach $21 thousand (The Economist Intelligence Unit, 2019). Moreover, major infrastructure investments made in recent years have improved the state of logistics in the country and have become an important factor in their competitiveness.

China's success is a big concern in the U.S. As early as 1993, the U.S. was headed for a new technology policy – 'Technology for America's economic growth: the new course to build economic strength' – which placed the task not only to ensure the country's world leadership in fundamental science, mathematics and engineering, but also the active support of the state of economic growth and competitiveness of the economy (Rjabenko, 2014). Research and development (R&D) spending in the U.S. is the largest in the world in absolute terms. Today the U.S. share in R&D expenditures is about 25% (China's share is more than 22%) and is expected to reach $581 billion by 2019, according to Global R&D Funding Forecast (R&D Magazine, 2019); 12% of this is attributed to state funding, 69% is business spending (which is more than any individual country spends overall except China), and 19% is for universities and non-profit foundations. According to the U.S. Bureau of Economic Analysis the returns from R&D annually provide 6.6% of GDP growth, and from every dollar spent on R&D the U.S. economy receives $3 on average each year (Zimenkov, 2014).

In recent decades, the U.S. has been experiencing severe competition from other OECD countries (e.g., Germany, Japan, and South Korea), whose total expenditure on R&D is larger than that of the U.S., as well as from China whose R&D expenditure already exceeded $485 billion in 2018 and continues to grow at a rapid pace. China has already surpassed the U.S. in terms of exports of high-tech products, although U.S. state institutions rigidly control so-called 'critical technologies', the

export of which is prohibited, as it can inflict damage on the economic security of the U.S. and lead to loss of scientific and technological leadership. Our knowledge about university-business interactions is predominantly limited to developed countries, with little knowledge from developing countries (Wang et al., 2020).

The recent changes in global markets, such as a slump in raw material prices, the stock market collapse, especially in China and the U.S., yuan rate depreciation and the U.S. Federal Reserve's interest rate rise has provoked investors to rush primarily to the U.S., where small cyclical growth has been noticed. The economic growth is present here due to the relative stability of the financial sector, growing availability of credit resources, growth of the private sector, and an increase in demand. Private sector companies increase investments and create new workplaces. In March 2014, employment in the private sector exceeded the pre-crisis maximum for the first time (reaching 116 million people) and continues to grow (127 million people in 2018)[4] (US Department of Labor, Bureau of Labor Statistics, 2018). The U.S. economy growth was 2.9% in 2018, which increased by 3.1% in the first quarter of 2019. From January 2018 to January 2019, exports of goods and services grew faster than imports: imports fell by 3.7%, while exports grew by 3%.[5] Unemployment fell from 9.6% in 2010 to 3.9% in 2018 (US Department of Labor, Bureau of Labor Statistics, 2018).

Aggregate demand is growing because of both the increase in employment and an improvement in household balance sheets as the debts accumulated before the global financial crisis are now being paid. It should be noted that the shale revolution also played a major role in the transition to a phase of economic recovery.

According to BP data, the U.S. has regained global leadership in oil production, which they lost in 1975. Average oil production was in the region of 10.9 million barrels per day in 2018, compared with 10.4 million barrels per day in Saudi Arabia and 10.7 million barrels per day in Russia (US Department of Energy, 2018). Although the oil price slump led to a decline in oil well drilling, it did not lead to a sharp decline in oil or gas mining. The industry success has had a positive impact on the entire U.S. economy, lowering energy costs and thus increasing the competitiveness of American companies, and therefore creating new possibilities in the oil and chemical spheres of the country (Kondrat'ev, 2015). The U.S. will most likely act as a driver of economic growth for a long time, and only then will capital flow to Europe, and, perhaps after that, the developing world will become involved.[6]

In the EU, by contrast, the economic growth perspective remains quite weak and uncertain. The program of a monetary stimulus, attempted by the European Central Bank, a weak Euro, and low oil prices have caused a failure in restoring previous levels of investment. In 2018, the EU economy grew by 2% (European Commission, 2019), while in 2014, growth was less than 1%. Countries in the European periphery are only starting to climb out of the crisis thanks to structural reforms undertaken after the crisis and the fall in wages, which increased their inter-European competitiveness. As a result, the main investors' confidence has grown. Nevertheless, the implementation of more fundamental reforms is needed on both European and national levels in order to achieve long-term effectiveness (Kondrat'ev, 2015).

The U.S. and other developed countries' leadership in the scientific and technology spheres, as well as world finance, has led to a change in investment trends in recent years. Among investors, there has been a sharp *turn* – the transition from investments in China, as the leader of business activity and other developing countries with cheap labor resources, to investments in the U.S., as the world's scientific and technological leader, and to other developed countries with the prospect of gaining substantial profits from the introduction of technologies of the sixth technological structure. These two poles create instability in the global economy, which, together with other factors, is reflected in moving capital and growing uncertainty in financial markets.

The second trend is uncertainty growth in financial markets, capital outflow from developing markets to developed countries, and formation of new markets.

Uncertainty in financial markets is caused by not only turbulence in business activity centers but also growth in developed countries' public debt, which can be compared with GDP and even exceeds it in some countries, in addition to the growth of the global derivatives market. In 2019, Japan had the highest government debt level – 234% of GDP, followed by Greece with 182%, Italy with 127%, Portugal with 117%, and the U.S. with 109%. In Belgium, Spain, the United Kingdom, and France, the level of public debt almost reached the size of GDP or is getting close to it.[7] In absolute terms, the highest level of public debt is in the U.S., which reached $22.3 trillion by June 2019.[8] Statistics on countries' external debts is even more frightening. For example, some countries have an external debt to GDP ratio of more than 300%: Ireland – 732%, Cyprus – 494%, Singapore – 416%, and the United Kingdom – 312%. The ratio is less than 300% in the following countries: Switzerland – 265%, Belgium – 241%, Greece – 218%, France – 216%, Finland – 207%, Germany – 143%, Canada – 121%, and Italy – 120%. In the U.S., it is at 96%. Among BRICS countries, the highest level of external debt compared to GDP is in South Africa – 47%, followed by Brazil – 30%, Russia – 27%, India – 20%, and China – 14%.[9]

A statistical study on the number of derivatives in the world, held in May 2019, shows that their volume has reached an astronomical figure of $544 trillion (Bank for International Settlements (BIS), 2019). This is 28 times more than the size of the U.S. GDP.

According to United Nations Conference on Trade and Development (Figure 2), in conditions of uncertainty and instability, the largest transnational corporations increase their assets in cash, particularly in the health sector, technological sector, industry, and consumer services and goods.

In contrast, uncertainty and instability in financial markets provoke an outflow of capital from developing markets. By the end of 2015, developing markets experienced a net outflow of capital for the first time since the 1980s (Katasonov, 2015). However, according to data from the Institute of International Finance, investments in the economies of developing countries began to increase in 2016 and reached $1,139 million in 2018 (Figure 3).

It should be emphasized that, until recently, developing markets played the role of a global engine of economic development. However, the trends of 2015 suggest that with the remaining volume of outflows from developing markets, there is a double reduction of investment in these countries. Until 2015, the markets of developing

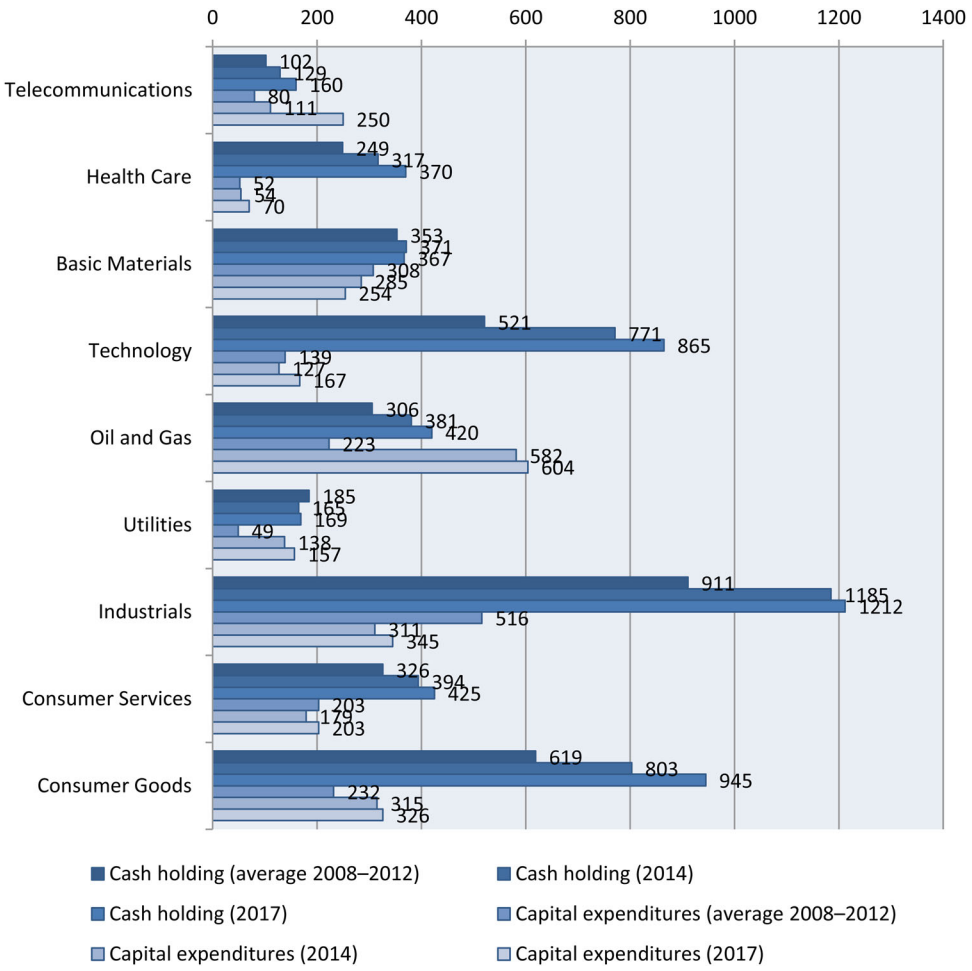

Figure 2. Cash holdings and capital expenditures of the top 5,000 MNEs, by sector, billion U.S. dollars. *Source*: made by authors according to United Nations Conference on Trade and Development (UNCTAD, 2018).

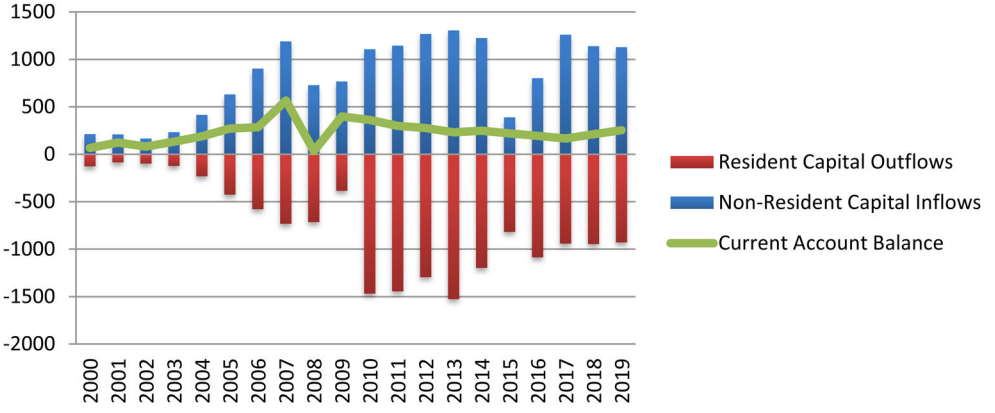

Figure 3. The movement of capital in the emerging economies, billion U.S. dollars. *Source*: made by authors according to IIF data.[20]

countries stayed profitable thanks to an abundance of raw materials and natural resources. Rapid population growth, significant improvement of the quality of life, and consistent economic development allowed developing markets to become countries with attractive investment opportunities and perspectives. However, not everything is irreversible. According to IMF data, new markets will attract almost 50% of foreign direct investments of international monetary flows in the near future. IMF officials consider the markets of Africa; the Middle East; Brazil, Russia, India, China, South Africa (BRICS); and some countries in Asia to be attractive. Presumably, the BRICS will account for almost 50% of global GDP growth by 2020. According to experts' estimations, the population of our planet will be 9.1 billion people by 2050. In terms of aggregate consumer ability of the world middle class, it is estimated to increase by more than double by 2030, reaching $56 trillion. By 2020, Asian countries will account for more than 80% of consumer demand, and they will urgently need investments worth about $7.5 trillion. The majority of investments will be required in high technologies and innovation. This completely new sector of the economy will be necessary to meet the needs, as well as improve the quality and living conditions, of billions of middle-class consumers from developing countries. However, considering the current turbulence in the global economy, it is very difficult to make any predictions, especially given long-term forecasts.

Despite this, it is fairly obvious that the U.S., which relies on a solid scientific and technological base with skilled labor, is taking the policy of neo-industrialization (reindustrialization) inside the country. While their foreign economic policy involves stepping away from actively supporting the World Trade Organization and offering trans-Atlantic and Pacific alliances for its vassals, it offers other countries uncertainties and chaos. The 'theory of controlled chaos' will allow the U.S. to continue to dominate in the world and ensure that its military-industrial complex continues having huge budgets in the arms race to quash competition and continue to exploit the rest of the world (Matyushok, 2015). The neo-industrial marathon will involve two poles, on the one hand, the U.S. and other developed countries, and on the other, Russia, China, India, and perhaps other developing countries, which will determine the trends of global economic development this century. A new class of assets called cryptocurrencies adds to global uncertainty (Ho, 2020).

The third trend is neo-industrialization, which is an objective process of the newest industrial model formation based on high-technology structures.

It is assumed that this model can be implemented with the active industrial policy of the state, stimulating the most important and promising 'growth points' in the following major areas:

- Creation and development of the most important new industries of the 6th technological structure such as bioeconomy, nanotechnology, cognitive technologies, nature-like technology, robotics, and new medicine;
- Organization of the geoindustrial complex on the nano-bio-info-cogno-technologies – convergence technologies;
- Wider and more thorough implementation of new digital technologies;
- Intensification of innovation and investment activities;

- Formation (creation) of the latest manufacturing and technological systems and innovation clusters; and
- Institutionalization of the knowledge economy, opening of new industries, and creation of conditions for the development of traditional industries (Lanskaya et al., 2015).

Neo-industrialization is primarily an economy based on knowledge, human resources, and networks. Computers, communications, and network technology dominate this new economy. Mental performance, too, is becoming more and more important. Driving the new smart economy includes making communications, business transactions, science and research, e-commerce, and innovation clusters the basis of economic activity. Before, the foundation of the economy was capital, whereas now its main resource is knowledge.

However, capital is not losing its investment function. The movement of capital does not simply imply the inflow of money; it is also the inflow of knowledge, new technologies, intelligent workers, and modern management. Neo-industrialization is a key tool of this new powerful economy, which could unite enterprises, science, and state structures in a common system. In economics and sociology, this process is known as the triple helix model.

Nowadays, a glimpse of the sixth technological structure can already be seen in the leading countries of the world: the U.S., Japan, Russia, and China. Their characteristics are development determination, and the obligatory use of high scientific technologies.[10] Far-looking countries with long-term planning put bio- and nanotechnology, genetic engineering, membrane and quantum technologies, integrated photonics, micromechanics, and nuclear power at the forefront. Cumulative achievements in these designated areas will inevitably lead to the creation of a quantum computer, for instance, or artificial intelligence (AI), and in the end this will provide a completely different level, not only in the systems of government and society, but in the entire economy.[11]

The growth of investments (Škare & Sinković, 2013) in technological and innovative clusters enhances the competitiveness of economies and gives a powerful boost to their development. Firstly, cluster of nanotechnologies includes nanoelectronics, nanomaterials and nano-equipment. Secondly, cluster of biotechnology includes biomedicine and genetic engineering. These are followed by IT (Batori et al., 2008), which is progressively getting into all spheres of the society, economy, and human life.

As estimated by experts, productivity can be increased by 2.5%–3% a year or more thanks to these innovations, and per capita income can be dramatically increased. Improving productivity is the most important direct consequence of the innovative development of the economy. The transfer of production to digital technology inevitably leads to a reduction in the number of workers. A digital (smart) economy needs professionals who possess the necessary knowledge and can use the latest technology aiming to increase not only the volume but also the quality of products and services. Digital industry creates services and competencies that are essential for transformations in both technology and business. As a result, new values appear, and, as an

inevitable consequence, the competitiveness of other activities and sectors increases. In turn, every industry either directly or indirectly affects development, employment, and regional organization.

According to many respected experts, neo-industrialization will help get the global economy out of stagnation. The ever-changing global market, spurred by the rapid development of developing markets and the appearance of new technologies, accelerated the pace of most activities, from developing new products to studying consumer feedback. According to the latest studies and forecasts, IT will transform many spheres, such as telecommunications, entertainment, media, retail, banking, healthcare, and technology by 2020 (Krasavina, 2019). This will facilitate the replacement of today's business models to more modern ones due to the transition to the digital economy, which meets the latest requirements regarding the use of technology, as well as globalization.

The changes in the sphere of IT technologies are so significant that they have formed a powerful *fourth trend, which is the 'digitalization' of the world of people and the world of things, and the creation of a 'smart' economy (new technology trends).*These trends will be manifested in

- business transformation under the influence of the Internet of things (IoT), reduction of the role of human error, the new environment for decision-making, and new business processes;
- convergence of IT and operational activities;
- security of personal data and protection of business via devices and applications;
- large volume of data and analytics, data integration, and new possibilities;
- smart devices and sensors;
- ecosystems that support growth: IT services and IoT;
- new applications for IoT: general and industrial solutions; and
- fifth-generation (5G) mobile technology and AI.

Digital technologies have great potential opportunities. Thanks to them, the time and space costs of implementing global transaction contracts via new technological and innovative platforms are reduced (Matyushok & Krasavina, 2017).

The mastering of new digital technologies by developing markets can be seen in global mobility trends. According to the International Telecommunication Union (ITU), in 2018, there were more than 8.16 billion mobile-cellular telephone subscriptions (more than 5 billion unique subscribers) in the world. Of these statistics, the most shocking is that about 6.4 billion of them (80%) live in developing countries, with the majority being in China and India. For example, in 2010 alone, the number of mobile technology users increased by more than 300 million in these two countries, far surpassing the U.S. Thus, the 'epidemic' of digital technology continues to take over the world. With close to 1.2 billion subscribers, China is now the largest mobile market globally. Particularly impressive is the rate of growth in mobile Internet penetration, which reached 58% at the end of 2018, at which point the number of smartphone connections in China surpassed 1 billion. We expect China to retain its status as the largest smartphone market in the world, with more than 1.4 billion connections.[12] Similarly, there were 600 million mobile subscribers in India in

Table 2. The volume of e-sales (top 10 countries).

Country	2013	2014	2015	2016	2017	2018
China (except Hong Kong)	315.75	426.26	562.66	714.58	871.79	1,011.28
Increment, %	47.0%	35.0%	32.0%	27.0%	22.0%	16.0%
USA	264.28	305.65	349.06	394.43	442.55	493.89
Increment, %	16.5%	15.7%	14.2%	13.0%	12.2%	11.6%
Great Britain	70.39	82.00	93.89	104.22	114.64	124.96
Increment, %	17.0%	16.5%	14.5%	11.0%	10.0%	9.0%
Japan	62.13	70.83	79.33	88.06	96.87	106.07
Increment, %	17.9%	14.0%	12.0%	11.0%	10.0%	9.5%
Germany	51.91	63.38	73.46	82.93	91.97	99.33
Increment, %	21.7%	22.1%	15.9%	12.9%	10.9%	8.0%
France	34.21	38.36	42.62	46.13	49.71	53.26
Increment, %	13.2%	12.1%	11.1%	8.2%	7.8%	7.1%
South Korea	29.30	33.11	36.76	40.43	44.07	47.82
Increment, %	12.6%	13.0%	11.0%	10.0%	9.0%	8.5%
Canada	20.98	24.63	28.77	33.05	37.61	42.67
Increment, %	17.7%	17.4%	16.8%	14.9%	13.8%	13.5%
Russia	15.06	17.47	20.30	23.40	26.88	30.91
Increment, %	27.4%	16.0%	16.2%	15.3%	14.9%	15.0%
Brazil	13.34	16.28	18.80	21.34	23.79	26.17
Increment, %	28.0%	22.0%	15.5%	13.5%	11.5%	10.0%

Note: e-sales refer to sales of goods and services ordered on the Internet using any device. Type of payment doesn't matter.
Source: made by authors according to http://www.emarketer.com/Article/Retail-Sales-Worldwide-Will-Top-22-Trillion-This-Year/1011765.

2012, and by March 2019, this had ballooned to 1.16 billion subscribers (Telecom Regulatory Authority of India, 2019). Most studies viewed ICT measurements as disjointed indicators in which the bond in ICT proxies are not linked together, but in reality their investments are highly causative. (David & Grobler, 2020).

International Data Corporation (IDC), an international research and consulting company, estimates the total amount of all international electronic transactions at $16 trillion, which equals approximately 13.8% of global sales. This reflects the gigantic scale of the e-economy (Table 2) and proves that the world is becoming more and more 'digitalized'.

Today, millions of various devices can access the Internet. Therefore, companies can analyze more of the information transmitted and processed without human intervention. This is the beginning of a new era in which companies will be more intelligent based on information that was previously not obtainable. By receiving analytical data in real time through the IoT, companies can improve their operations, increase the efficiency of various processes, and develop new business models and services (Qin et al., 2014).

According to the latest statistics data, more than 56% of the world population uses the Internet. Almost half of all Internet users are from Asia (Table 3).

According to IDC forecasts, by 2022, the market volume of the IoT will reach $1.2 trillion.[13] In the coming years, the industry will undergo significant changes, namely in the following spheres: IT (72%); telecommunications (66%); entertainment, media, and publishing (65%); retail services (48%); banking (47%); and bio-medical science (38%). For many companies, technology takes up a new role as means of generating profits and creating new business models.[14]

Further development of the industrial IoT is also expected; instead of introducing prototypes and concepts, which has occurred in recent years and months, large-scale commercial development of such ecosystems will begin.

Table 3. The use of the Internet in the world.

Regions of the world	Population (2019 Est.)	Internet users		Internet coverage (% population)	Growth, times 2000–2019
		December 31, 2000	March 2019		
Asia	4,241,972,790	114,304,000	2,197,444,783	51.8%	19.2
Africa	1,320,038,716	4,514,400	492,762,185	37.3%	109.2
Middle East	258,356,867	3,284,800	173,542,069	67.2%	52.8
Europe	829,173,007	105,096,093	719,365,521	86.8%	6.8
North America	366,496,802	108,096,800	327,568,127	89.4%	3.0
Latin America/Caribbean	658,345,826	18,068,919	444,493,379	67.5%	24.6
Oceania/Australia	41,839,201	7,620,480	28,634,278	68.4%	3.8
Total in the world	7,716,223,209	360,985,492	4,383,810,342	56.8%	12.1

Source: made by authors according to http://www.internetworldstats.com/stats.htm.

In 2017, according to TAdviser, the volume of the domestic IoT market in Russia amounted to 1.5 billion dollars. This amount includes the cost of robotic systems, sensors, software and platforms, infrastructure and networks, integration, and other similar services. By 2020, the volume of this market can grow up to 270 billion rubles. In the meantime, costs of most industrial enterprises in Russia for digitalization and the development of IT infrastructure did not exceed 1% of their budget, as noted in a 2018 joint study by the Ministry of Industry and Trade.

However, the capabilities of current communication networks are clearly not enough to fully use the capabilities of connected devices, and the main role in the digital breakthrough of connected devices will be 5G, as 5G networks are another step in the evolution of mobile communications. While 5G is still undergoing tests, in the near future, it will lead to economic and technological breakthroughs. 5G widespread use will begin in coming 2–3 years.

In 2018, the first attempts to introduce 5G mobile technology were conducted worldwide; for example, 5G was used to support the work of drones during the Winter Olympic Games in South Korea. In 2019, 5G 'islands' started to appear all over the world in large-scale pilots and technology test zones. The digitalization of the society has been a buzzword among operators over the past few years. As such, testing of the 5G network in Seoul began in December 2018. The network is being developed by the three largest mobile operators in South Korea – SK Telecom, KT, and LG Uplus. At the end of August 2018, Juniper Research called these operators leaders in the development of 5G worldwide. In addition, Japanese operators NTT DOCOMO and Softbank, American AT&T, and Chinese China Mobile were also in the top five.

In Russia, the mass construction of 5G networks would begin later – at the end of 2021. The Ministry of Communications and Mass Media is coming up with the idea that the network will be built by a consortium of operators; this will make it possible to introduce technology faster and cheaper.

It is clear that mobile Internet will be even faster, but this is not a key change. The 5G network will provide a universal connection between anything and everything, combining broadband, energy-intensive protocols with narrowband, and energy-saving technology. This will open new areas that are inaccessible for 4G: machine-to-machine communication on the ground and in the air, Industry 4.0, IoT, and services for business (especially, business-to-business). The 5G business is expected to earn $3.5 trillion by 2035 and create 22 million workplaces.[15]

China and the U.S. are fighting for leadership in the development and implementation of 5G networks. The impetus for development is the potential for significant economic benefit of a technological breakthrough. Selling patents, software, and equipment; arranging the appropriate infrastructure; and developing mobile devices will bring huge profits to the winner of the race.

Since 2013, China has been supporting the development of a new generation of communications at the state level. The government committee that manages the interaction of Chinese manufacturers in the work on promising technologies is engaged in the development of 5G. Therefore, Huawei and ZTE already offer basic equipment and mobile devices supporting 5G in the international market.

In the U.S., the government does not coordinate the efforts of development companies. The authorities mainly protect their manufacturers with economic measures, such as introducing duties on Chinese equipment and protecting mergers and acquisitions of U.S. companies from Chinese competitors.

The competition between the U.S. and China is particularly strong in the European market. The U.S. Department of State has called on EU countries to refuse purchasing Chinese telecommunications equipment for 5G communication networks, stating information security issues. The growth of the struggle for markets will intensify as technology develops.

The 5G communication networks, together with big data analysis and IoT, are designed to become one of the foundations of the digital economy and the first stage of the new technological revolution, the main driving force of which should be AI.

The ITU, in collaboration with experts from the McKinsey Global Institute (the business and economics division of McKinsey & Company), modeled the economic effect of AI in its study (Bughin et al., 2018). The authors took into account factors such as the transformation of the global labor market under the influence of automation, the need for fundamental changes in the skills of workers, and the use of AI by individual companies. The impact of AI on the global economy will pass along seven main channels: an increase in production, replacement of existing products and services, innovation and expansion of product lines and services, economic benefits of increased global flows, value creation and reinvestment, costs of transition and implementation of AI, and negative externalities.

ITU arrives at its conclusions by considering that AI in the future may directly affect competition, with consequences for companies, labor markets, and national economies. AI combines five groups of technologies – machine vision, natural language, virtual assistants, robotic process automation, and enhanced machine learning – and generally has great potential to contribute to global economic activity. Some companies will try to use one of the AI technologies to perform certain functions, whereas others may apply all the AI technologies mentioned above.

According to a survey conducted by Stripe in September 2018, the most impactful tech trends for enterprises worldwide were identified among the leading developers and technical directors, and AI came out in first place (Figure 4).

According to McKinsey, AI could potentially deliver additional global economic activity of around $13 trillion globally by 2030, or about 16% higher cumulative GDP compared with today. The introduction of AI technologies will occur rapidly, and by

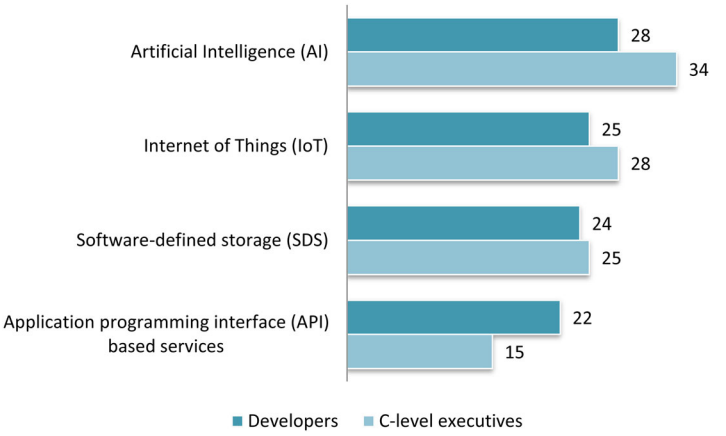

Figure 4. Most impactful tech trends for enterprises worldwide, %. *Source*: compiled by the authors according to Stripe (Stripe, 2018).

2030, it will generate 1.2% of the growth in global GDP – more than all previously implemented technologies. At the same time, the economic effect of AI can manifest itself gradually, at an accelerating pace, and be noticeable only over time due to the need for substantial costs of implementation at the start, thus amplifying the effects of competition and complementarity afterward.

AI can improve the efficiency of the global economy, but the distribution of the benefits obtained is likely to be uneven (Park, 2018). The introduction of AI (Gerhard Neipp, 2014) will increase the lag of developing countries from developed ones, thereby exacerbating the current digital divide between states. At the company level, the use of AI can lead to an increase in the performance gap between leaders in implementing these technologies and those who are slow in implementing or have not used the technology at all. Finally, AI can shift demand in the global labor market from professions requiring routine tasks to socially and cognitively-oriented specialties, as well as activities that are difficult to automate (Birinci, 2019).

In other words, if the development and introduction of AI technologies proceeds inefficiently, the inequality between national economies, individual companies, and employees in the labor market may be exacerbated, which will fuel potential social conflicts in turn. In order to avoid this, governments of countries leading AI, together with businesses, must provide support and a smooth transition for workers to these newly demanded jobs, and people themselves will need to learn new skills in accordance with the needs of a dynamically changing labor market.

As for Russia, now in the framework of the national program called the 'Digital Economy', there is a discussion about the creation of special legislation regulating the sphere of robotics and AI. While experts proceed from the position that a human stands behind every action of a robot who is liable in the event of damage (e.g., if the damage is caused by a design defect, the manufacturer is liable, and if by software failure, the developer is liable).

The fifth trend is the end of the era of hydrocarbon fuel, change in the structure of energy balances, and formation of new energy trends.

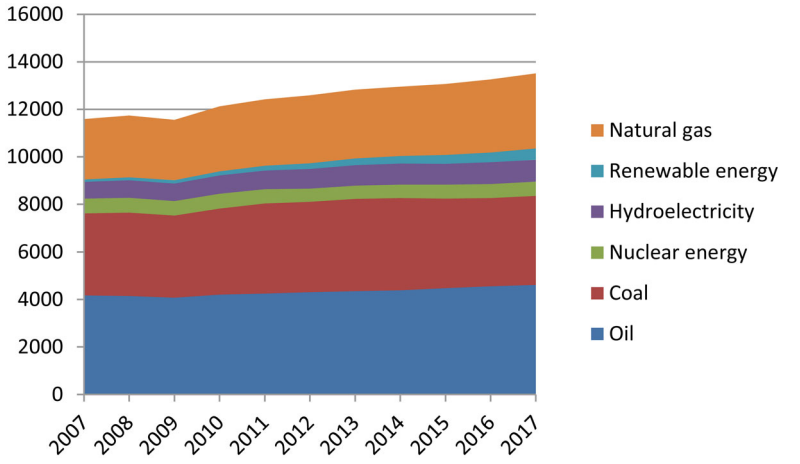

Figure 5. Global primary energy consumption by energy resource types (million tons). *Source*: made by authors according to BP data (BP 2018).

The burning of fossil fuels that are transported over long distances, along with the consumption of relatively large amounts of energy accompanied by weak control of energy flows, were the basis of industrial 'power energy'. In contrast, the basis of the post-industrial 'smart' energy will be renewable energy and nuclear power, as well as the efficient use of relatively small energy flows (European Commission, 2014; U.S. Department of Energy, National Energy Technology Laboratory, 2013). This is not the usual imbalance of the market when the supply of hydrocarbons exceeds demand due to a reduction in economic growth. New sources, energy generation, and transfer technologies are becoming increasingly important. A growing body of evidence suggests that the global energy sector is on the verge of a revolution (IEA, 2012). The main directions of such a revolution are the spread of renewable energies (e.g., photovoltaics and wind power); extensive spread of energy-saving technologies; use of compact and ultra-efficient energy; integration of energy in the techno sphere; decentralization of power; and creation of 'smart circuits' and energy systems, 'energy efficient homes', 'energy efficient cities', and the energetics of photosynthesis (clean renewable energy).[16]

Amid the growing and rapidly changing demand for electricity, the problem of its optimal allocation between consumers has intensified. On a level with conventional fossil energy, renewable energy sources are starting to be used increasingly (Figure 5). The technologies for their use are becoming more profitable and convenient. However, most of these sources cannot produce the required amount of energy constantly: their effectiveness depends on the season, time of day, current weather, and other environmental conditions. Real-time balancing of the demand and supply of energy produced using renewable and non-renewable resources requires intelligent control systems (Westkämper, 2014).

Modern methods, such as the method of 'swarm intelligence', allow optimization of power distribution to bind objects of the current using various centers of energy production (e.g., solar panels, wind mills, and cogenerations), on the one hand, and the centers of consumption (e.g., homes, factories, and electric vehicles) on the other.

New smart solutions are able to calculate the optimal ways and channels of energy transfer between suppliers and customers (Chebbi & Derbali, 2015) and predict supply and demand, while taking accumulated historical data into account.

It should be noted that the environmental factor is one of the most important in today's energy development. Current national economic legislations, legal and economic mechanisms in the Kyoto Protocol and post-Kyoto agreements, and the environmental conference in Paris all aim to encourage the transition to new ultra-efficient energy. The inertial scenario assumes that the volume of resources used and waste production will grow at a rapid pace and, after 2030, will result in an acute crisis. In the stagnant scenario, society will reduce its pressure on the environment using legal mechanisms to reduce energy and resource intensity. In the innovative scenario, which is also called the renewable-nuclear scenario of resource consumption and waste generation, there can be a high percentage of Nuclear Power Plants (about 30%), compared with the global average structure of electricity generation (Bushuev, 2014). According to this scenario, global power energy will grow at the fastest rate, and this will bring it to a state of an 'electrical world'. It is expected that the share of electricity in global final energy consumption will approach 28% by 2030 and 37% by 2050. By 2050, developing countries must achieve a modern standard of energy consumption, which is 5,000 kWh per person per year. As a rule, a reduction in quantitative differences will be followed by the growth of qualitative differences. It is expected that in most developed countries after 2030, the formation of ultra-efficient compact nature-like energy and innovative energy systems will begin (although in our opinion, this will occur much earlier), and it will be based on the latest 'smart current' technology. The result will be fundamental technological changes in the global energy sector, as regulatory and geopolitical factors recede into the background (Bushuev, 2014).

The technology for renewable energy usually develops worldwide due to subsidies, which amounted to $278.9 billion in 2017 (Frankfurt School-UNEP Centre/BNEF, 2018). Global investment in renewable energy varies year on year, but it is generally on an upward trend. By 2030, according to the American Council on Renewable Energy,[17] renewable energy sources will attract $1 trillion of investment. Ongoing governmental support and the rapidly decreasing cost of electricity generation from renewables will increase their share in the growth of electricity generation up to 50% by 2040. Thus, the use of biofuels should amount to 4.6 million barrels a day,[18] (i.e., it will triple), and the use of renewables for heat will more than double (Elistratov, 2011).

The highest growth in the share of renewable energy in electricity production is expected in OECD countries at 37%. The growth of renewable energy will be equal to the net increase in the supply of electricity in these countries (Kondrat'ev, 2015). Along with this, countries outside the OECD, led by China, India, and some Latin American and African countries, will double the growth of energy generation based on renewable energy. As for wind energy, its share in total generation will be higher than the proportion of other types of renewable energy – about 34%; the share of hydropower will be about 30%, and solar power will account for about 18%. We should not forget that the energy balance of the world will continue to undergo changes: the share of wind and solar energy will quadruple. In the EU, countries that use wind energy will reach 20% of total electricity generation, and during summer in

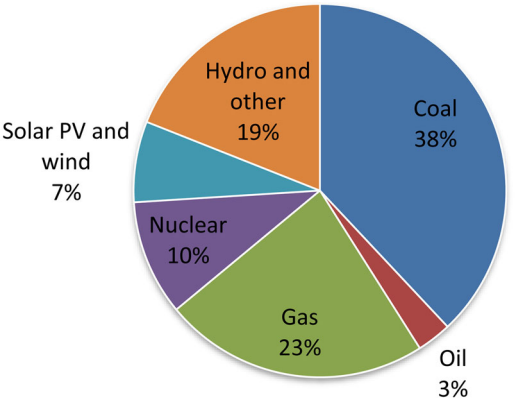

Figure 6. Electrical power generation by fuel types in 2018, %. *Source:* made by authors according to IEA data (IEA, 2018).

Japan, peak demand will use about 37% of the solar energy in the whole energy balance.

With regard to nuclear energy, it will stay a part of national energy strategies, including in countries implementing a phased closure of nuclear power plants and looking for an alternative. The share of nuclear energy in world electricity generation, as is known, peaked almost 20 years ago. Experts believe that this percentage will only rise by 1% and will amount to about 12% (Figure 6).

The growth of nuclear power can be observed mainly in countries with state support and regulated prices. By 2040, China will account for 45% of the total increment in the production of nuclear energy; India, Korea, and Russia will have 30% in total. The U.S. plans to increase its generation of nuclear energy by 16%. Japan will restore the production of nuclear energy, but the level that preceded the Fukushima disaster will not be reached. In the EU, the generation of nuclear energy will decrease by 10% (Zakharov & Ovakimyan, 2015).

The sixth trend is the shift from a raw materials market to a services and technologies market. It is generally recognized that the economy, which relies on raw materials as the main source of GDP, cannot continue to be competitive. This economy has no future. Analysis of the global market indicates that, nowadays, the cheap raw materials era has begun to rule the market. Since 2012, prices in global raw materials markets have been going down quite steadily (Figure 7). It is obvious that this trend will last (Reinhart, 2015), although today it is not easy to predict precisely for how long. In connection with cheapening raw materials and the transition of least developed countries to neo-industrialization, there has been a fairly steady trend of the increasing role of the technologies market.

It has become obvious lately that only the effective use of the most modern breakthrough technologies can enable new development models, which will also facilitate countries' transitions to higher technological structures. Investments in R&D have become a priority like never before. However, technology will not serve the purpose; it is more about relationships among employees that promote learning and information exchange (Ishrat & Rahman, 2020). Since technology can have an impact on the

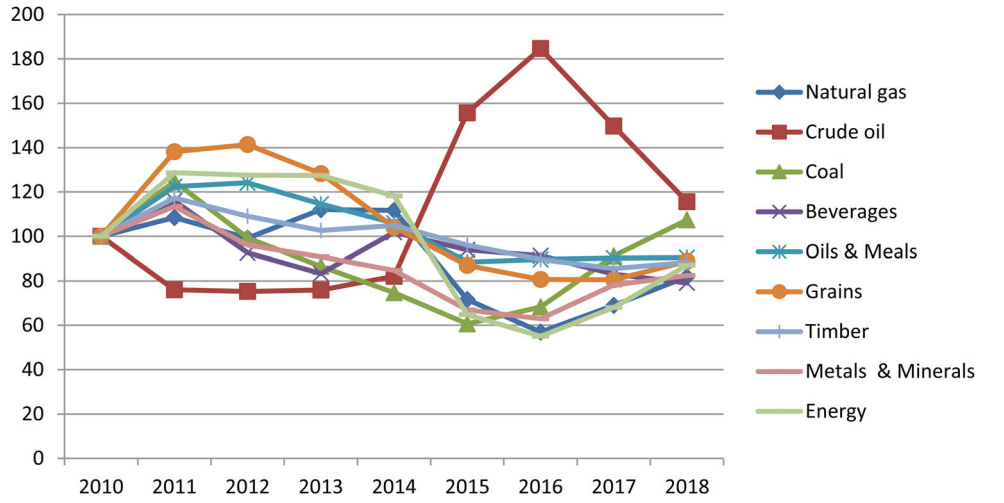

Figure 7. Dynamics of commodity price indices, 2010 – 2018 (2010 = 100%). *Source*: made by authors according to World Bank data.[21]

city itself; its dwellers; and the socio-economic, technological, entrepreneurial, and managerial spheres, one should take into account the interests of all involved parties in general, as well as the interest of society and the individual in particular (Strielkowski et al., 2020). Innovativeness is a dimension of entrepreneurial orientation with the greatest positive impact on this orientation (Hernández-Perlines et al., 2020).

In 2018, the sum allocated for R&D compared with the GDP amounted to 2.84% in the U.S., 2.84% in Germany, 3.5% in Japan, 2.25% in France, 1.52% in Russia, 1.27% in Italy, 1.72% in United Kingdom, 1.97% in China, and 0.85% in India (according to the Global R&D Funding Forecast; R&D Magazine, 2019). It is expected that in China and India, whose share in global R&D investments has already reached almost 25%, investment in R&D will be even higher in the future. As a result, the industrial production index, which has slowed down, and in some countries slumped during the crisis, will continue to grow, despite a fall in oil prices and other raw materials (Figure 8). Certainly, the U.S., controlling about 40% of the market of high technologies in the world and dominating in informational, financial, and military spheres while relying on its allies and international organizations, will continue to take active measures to slow down economic growth in not only Russia and China but also Germany and Japan, which are its major competitors.

Similarly, in the technology market, the growing trend of the services market is quite stable worldwide. At the end of the 20th century and beginning of 21st century, the following trends were clear in the global market of services in terms of the development of the service industry: a decline in the share of freight and other transport services caused by a decrease in the share of raw materials in international trade. Population income growth, tourism infrastructure development, and transportation improvement led to the increase in the share of tourism in international exports of services. Recently, financial, insurance, audit, and consulting services have become the main and most dynamically developing sectors. Most of the services (excluding

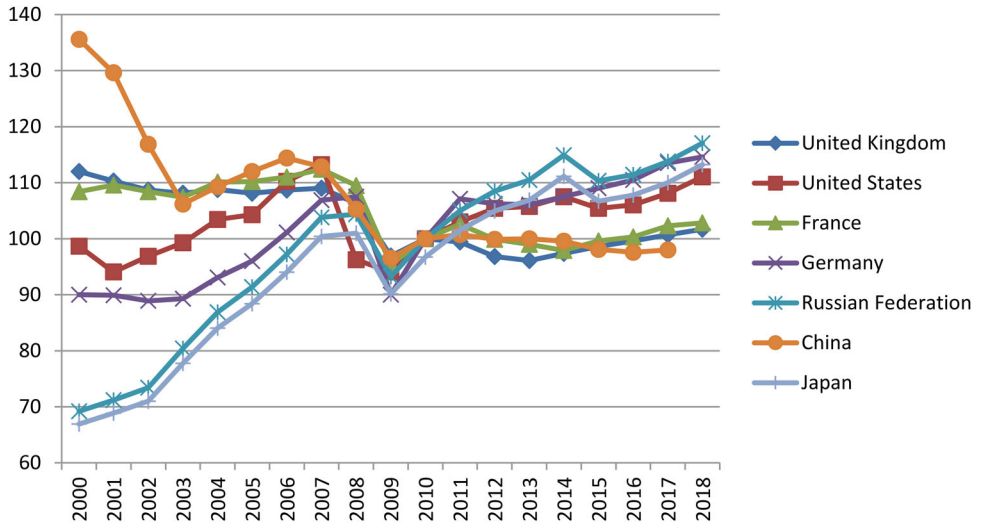

Figure 8. Dynamics of indices of industrial development of several countries (2010 = 100%). *Source:* made by authors according to: http://w3.unece.org, http://sdw.ecb.int/home.do, http://www.gks.ru, http://www.quest-trendmagazine.com, http://www.stats.gov.cn.

transportation and communication) developed independently from scientific and technological progress for quite a long time. During their development, they relied mainly on the use of labor resources and simple, sometimes primitive, technology. Today, the service is a wide field for using the latest achievements of scientific and technological progress. In particular, this applies to the field of electronics and ICT (Golonka, 2013). The U.S. and global economies are slowing from their peaks in 2018 and they are expected to slow a bit more in 2020. There is also a plethora of new technologies that look to be supported over the near term. IT and software will be the two most important technologies by 2021, according to respondents of a survey from the Global R&D Funding Forecast 2019 (Figure 9). They are also very visible components of all five new R&D technologies. Big data and AI – the next most selected technologies by 2021 – are also strong contributors in these new technologies (R&D Magazine, 2019).

These new technologies make it possible to not only transmit services at any distance but also accumulate, encode, and save them in electronic formats and store them on physical media, among other things. As a result, qualitative characteristics improve significantly: consumers have the opportunity access a huge array of information and high-quality on-line services, and also make use of the advantages of a much wider range of services. Currently, the service sector has become a huge part of the economy. Moreover, 63% of the global GDP[19] and 63%–75% of total employment in the sphere of material and non-material production is accounted for by the services sector. This is significantly higher than the share of merchandise trade.

The report on the results of the interstate panel on climate change at the United Nations, which was released at the end of 2018, was a call for those who still did not pay attention to the changes occurring on the planet. Mobile technology will allow people to live and consume more consciously than before. For example, in the capital

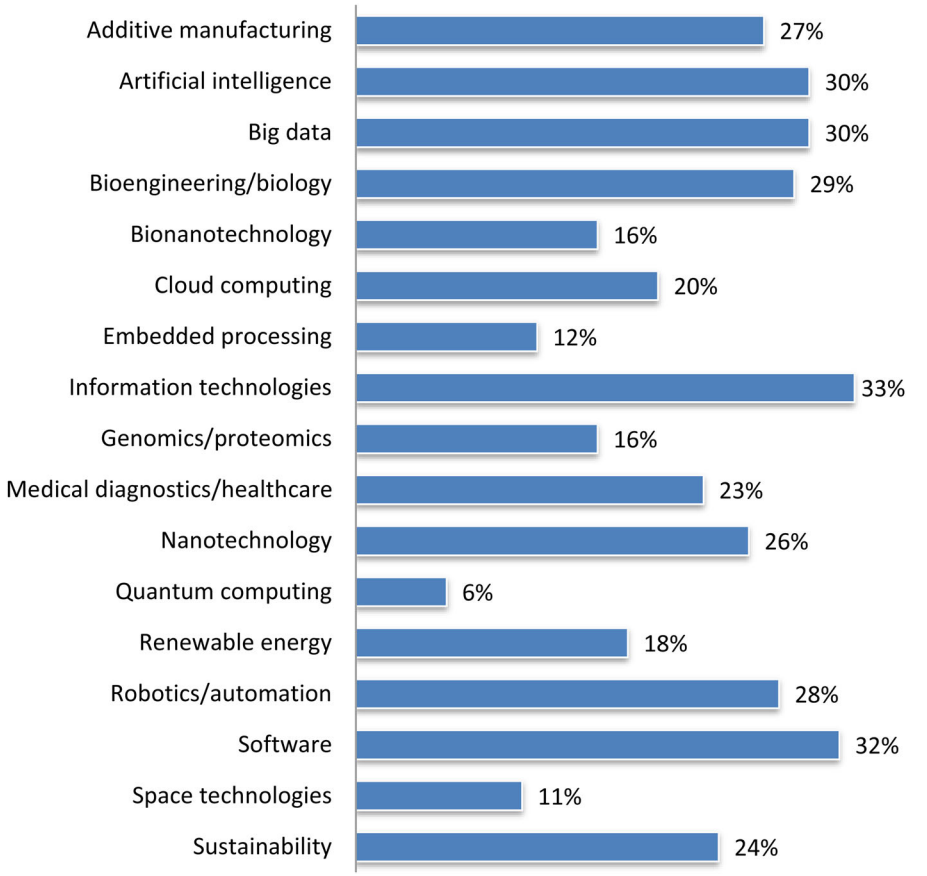

Figure 9. Most important technologies by 2021. *Source:* made by authors according to R&D Magazine data (R&D Magazine, 2019).

of Norway, the 'Too Good To Go' format services are gaining popularity (which helps reduce food waste) along with car sharing, food delivery services, and use of bicycles. The popularity of Tesla and electric cars (accounting for about 30% of all cars in Norway) proves that consumers are very susceptible to 'green' technologies and often require their introduction themselves.

The use of 'green' technology can be considered another current trend. This is true for the whole world and for Russia in particular. After all, it is not for nothing that the term 'greenwashing' appeared (ecological marketing that convinces the consumer that the manufacturing company cares about the environment).

Conclusion

This study indentified trends of Growing uncertainty in financial markets, capital outflows from emerging markets, formation of new markets, end of the hydrocarbon era, neo-industrialization, and technological and industrial revolutions, according to Manion and Evan (2001). Until recently, the history of global companies generally focused on the industry. Now this reality has changed – technology and commerce have made data more valuable

than material objects. Technology invades all areas of business: retail, advertising, healthcare, finance, manufacturing, and education, among others. It is almost impossible to compete with technology companies that create global platforms.

Every year, there are more and more technological breakthroughs. The market can quickly use new technologies and spread them at a fast pace: new products reach users several months after they were invented. As new technologies are being created at a faster and faster pace – and as they are adopted in markets at record speeds – it is fair to say that the future could be coming at breakneck speed.

Notes

1. https://www.imf.org/external/datamapper/PPPSH@WEO/OEMDC/ADVEC/WEOWORLD
2. Short for 'Emerging 7'.
3. https://www.imf.org/external/datamapper/PPPSH@WEO/USA/CHN
4. https://data.bls.gov/timeseries/ces0500000001
5. https://www.bea.gov/news/2019/us-international-trade-goods-and-services-january-2019
6. http://www.kommersant.ru/doc/2822748
7. http://worldpopulationreview.com/countries/countries-by-national-debt/
8. https://www.usdebtclock.org/
9. https://www.ceicdata.com/en/indicator/external-debt–of-nominal-gdp
10. https://interaffairs.ru/news/show/12231
11. https://interaffairs.ru/news/show/12231
12. https://www.gsmaintelligence.com/research/2019/03/the-mobile-economy-china-2019/743/
13. https://www.iottechnews.com/news/2018/jun/19/iot-worldwide-spending-hit-12-trillion-2022-says-idc/
14. http://world-economic.com/ru/articles_wej-331.html
15. https://www.qualcomm.com/invention/5g/economy
16. Scientists from the University of Florida in the U.S. have created a new artificial material, working on the principle of photosynthesis. According to experts, it can serve as a clean renewable energy source. It will require only rainwater and sunlight. Photosynthesis will be assimilated for the electrification of houses in the future. The material works in the following way: it absorbs solar light and the solar energy and, in turn, splits rainwater into oxygen and hydrogen. Something similar happens during photosynthesis wherein a plant uses sunlight to split water and carbohydrates are the main energy sources. Perhaps in the future, the sources of energy based on the new method will be installed on the roofs of houses, and they will turn rainwater into energy using sunlight, without having a negative impact on the environment. Professor Johan Rockstrom from the Stockholm Environment Institute has said that the chance that humanity will be saved from disastrous global warming is much higher today than at any time in the last 20 years. Rockstrom's optimism is based on the rapid speed of innovation development in the field of renewable energy sources, which has become possible in the past two or three years (http://portal-energo.ru/news/details/id/292).
17. https://acore.org/investmentsurvey/
18. Barrel is a unit of measurement for oil volume, which equals 42 gallons or 158,988 liters
19. https://www.cia.gov/library/publications/resources/the-world-factbook/geos/xx.html
20. http://enterprise.press/wp-content/uploads/2018/10/CFR_Oct18.pdf
21. http://www.worldbank.org/en/research/commodity-markets

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