DOI: 10.37930/2782-618X-2022-1-1-59-74

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CONCEPT OF CYCLIC SEQUENCE IN THE DISSEMINATION OF BASE-LEVEL TECHNOLOGIES IN THE ECONOMY AND ONTOLOGICAL CAUSALITY OF INDUSTRIAL SOCIETY THEORIES[1]

Abstract: The authors formulate and substantiate the hypothesis on sequential dissemination of base-level technologies in such segments as communications, production and transportation. This conceptual approach explains retroactive dynamics of the global economic system and the current situation in the world economy. The article establishes the cyclic repetition of basic technologies of technological modes and of relevant regimes that regulate global economic relations. The authors forecast which sectors will serve as global economic drivers and what foreign economic policies will be pursued by global leaders in the next fifty years. The article substantiates objective ontological causality behind the formation of industrial and new industrial society theories.
Keywords: base-level technology, industrial revolution, technological mode, foreign economic policies, new industrial society.

For citation: Tolkachev S. A., Tepliakov A. Yu. (2022). Concept of cyclic sequence in the dissemination of base-level technologies in the economy and ontological causality of industrial society theories. *Noonomy and Noosociety. Almanac of Scientific Works of the S.Y. Witte INID*, vol. 1, no. 1, pp. 59–74. DOI: 10.37930/2782-618X-2022-1-1-59-74.

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经济中基本技术普及的周期连续性概念和工业社会理论的本体制约性

摘要：本文提出并论证了通信、生产和运输等行业基础技术持续普及的假说。这种理性方法有助于解释世界经济关系体系的回顾性动态和当前的全球经济形势。指出了基本技术体制和相应的世界经济关系调节制度的周期性反复的特点。预测了哪些行业将成为全球经济的驱动力，

[1] This article was previously published in the magazine *Economic Revival of Russia* (Tolkachev, S.A., Teplyakov, A.Yu. The concept of a cyclical sequence of the spread of basic technology in the economy and the ontological conditioning of theories of industrial society. *Economic Revival of Russia*. – 2019. – No. 4 (62). – pp. 19-36 (In Russ.)). Republished in order to introduce the ideas contained in this article to a wider readership.

以及世界主要国家在半世纪规划中将采取哪些对外经济政策。论证了工业社会和新工业社会理论形成的客观本体制约性。
关键词：基础技术、工业革命、技术体制、对外经济政策、新工业社会。

引文注释：托尔卡切夫 S. A.、腾里亚科夫 A. Yu. (2022). 经济中基本技术普及的周期连续性概念和工业社会理论的本体制约性//智力经济和智力社会. 新兴工业发展研究所论文选, vol. 1, no. 1, pp. 59–74. DOI: 10.37930/2782-618X-2022-1-1-59-74.

Introduction

The transition to the new technological paradigm (TP), coinciding with the onset of the era of next industrial revolution, needs comprehensive political and economic substantiation based on deep historical traditions. One of such research paradigms is the family of long-term technological development theories. In a number of previous publications [Tolkachev 2017a, 2017b, 2017c, 2019], when developing S. Yu. Glaziev's concept of technological paradigms, the authors described the cyclical pattern of changing foreign economic policy forms in leading capitalist countries, in historical retrospective of the past 2–3 centuries. The essence of the pattern boils down to successively alternating (about half a century) dominance in the global system of economic relations of protectionism, then – of the free-trade policy, and, finally, of imperialism (Table 1). Herewith, protectionism is understood as the wide range of state measures to develop and protect emerging high-tech domestic industries from foreign competition. The free-trade policy implies liberalization of international trade, while imperialism ensures the most unhindered cross-border movement of international capital.

Table 1

*Alteration of foreign economic policy forms in leading capitalist countries in the 19th – 21st centuries**

Period	Foreign economic policy form
Until 1840s	Protectionism
1840s – 1870s	Free-trade policy
1870s – 1910s	Imperialism
1910s – 1940s	Protectionism
1940s – 1970s	Free-trade policy
1970s – 2010s	Imperialism
2010s – 2040s (?)	Protectionism
2040s – ?	Free-trade policy?

* Tables 1, 3, 7, 8 were compiled by the authors.

Research methodology

Assuming that this pattern is determined by regularity and a definite sequence of long-term technological changes in the economy, we will take the concept of basic innovation (technology), introduced in the1970s into scientific use by G. Mensch [Mensch 1979, 2019], as "the starting point" for the logical chain of evidence. He considers the uneven emergence of aggregates of innovations as the main reason for the long-term change in prosperity and depression phases in the economy. G. Mensch identifies base-level, improving and seeming (pseudo-innovations) types of innovations.

Basic innovation is the fundamental technological novelty with its industrial embodiment. Due to base-level innovations, new industries are created. In economic history, they manifest themselves in the form of clusters. These clusters emerged in waves with about a half-century interval, mainly on the downward waves of the Kondratiev cycles. However, the mass application of innovations began only in the phase of economic growth, and was accompanied by an increase in the number of improving innovations (technological innovations in current areas of economic activity, i. e., processes and products that are more advanced than the previous ones in terms of production efficiency and meeting consumer demand) and apparent ones (minor changes in product design).

Over time, the economic situation begins to stagnate, since the commercial potential of using basic innovations is close to exhaustion. There are no new particularly productive investment shifts, and investments are directed mainly to rental and speculative capital. In those industries where the previous growth was above average, excess capacity arises, creating prerequisites for the onset of a depression. It results in the situation of "technological stalemate", which requires new basic innovations to overcome it.

During periods of depression, entrepreneurs often have the alternative – to start investing in new technologies. If innovations are profitable, more and more entrepreneurs turn to them. Conditions are created for a new long-term economic recovery.

The category of general purpose technology, introduced in the 1990s by T. Bresnahan and M. Trajtenberg is similar in content to the concept of basic innovation [Bresnahan 1991, General Purpose…1998, Polterovich, 2009]. They describe this category as a technology to be open for numerous improvements, applicable in many sectors of the economy, complementary with other technologies and significantly increases their efficiency. Considering such features, each general purpose technology generates "the tree" of new technologies, fundamentally changing the technological structure of the economy, preventing the diminishing returns of production factors, and thereby supporting economic growth.

In the economic literature, especially "dense clusters" of basic technologies (general purpose technologies) are traditionally described by the concept of the *industrial revolution*. In the 1830s – 1840s, the term was introduced into scientific use by the French economist A. Blanqui, and began to be used actively, in particular, in the works of Marxists, to describe the explosive nature of socio-economic changes based on machine production that occurred at the turn of the 18th – 19th centuries in England, and then in other countries of the European civilization [Nureev, 2019].

In 1915, the British sociologist P. Geddes formulated, and in the1970s, the American economist D. Landis popularized the concept of the second industrial (technological) revolution. It covers the period of the second half of the 19th – early 20th century. Its beginning is considered to be the introduction of the Bessemer method of steelmaking in the1860s, it is based on the creation of the electrical engineering and chemical industries, its culmination is the spread of mass production. During this period, innovations begin to be generated no longer on the basis of random inventions by individual enthusiastic engineers, but in framework of institutionalized applied science. This revolution quickly swept through Western Europe, the United States, the Russian Empire and Japan [Hull, 1999]. At the end of the 20th century, scientists started talking about the new – information-technological revolution.

M. Castells associated it with the use of computers, communication systems, genetic decoding and programming, and dated its birth to the1970s. He wrote: "If the first industrial revolution was British, then the first information-technological revolution was American with a Californian bias. In both cases, scientists and industrialists from other countries played an important role in both the discovery and dissemination of new technologies" [Castells, 2019].

Table 2

Chronology and description of technological paradigms [Glaziev, 2010]

TP No.	Description of TP		
	Period of dominance	Technological leaders	"Core"
1	1770-1830	United Kingdom, Belgium	Textile production and mechanical engineering, cast iron smelting, iron processing, canal construction, water engine
2	1830-1880	United Kingdom, France, Belgium, Germany, United States	Steam engine, railway construction, steamship building, coal industry, machine tool industry, ferrous metallurgy
3	1880-1930	Germany, United States, United Kingdom, France	Electrical engineering and heavy machinery, steel production and rolling, electric power transmission, inorganic chemistry
4	1930-1970	United States, USSR, Western Europe, Japan	Automobile and tractor industries, non-ferrous metallurgy, durable goods production, synthetic materials, organic chemistry, oil extraction and refining
5	1970-2010	United States, EU, Japan	Electronic industry, computing and fiber-optic technology, software, telecommunications, robotics, gas extraction and processing, information services
6	2010-2050	United States, EU, China, Japan, Russia(?)	Nanoelectronics, molecular photonics and nanophotonics, nanomaterials, nanobiotechnology, nanosystem engineering

Finally, the term *fourth industrial revolution* was introduced into scientific use relatively recently. It appeared in Germany, at the Hanover Fair, in 2011, when discussing "Industry 4.0", this was the indication for the process of fundamental transformation of global value chains via dissemination of the "smart factories" technology [Schwab, 2016].

Main results and discussions

At the same time, considering technological "continuity" between "Industry 4.0" and the information revolution of the last third of the 20th century, it seems appropriate to consider these processes as phases of a single phenomenon – the third industrial revolution. Moreover, in modern economics, there are authoritative researchers who substantiate exactly this approach to the "numbering" of the current industrial revolution (for example, [Rifkin, 2014, Shchedrovitsky, 2019]).

Since the era of each industrial revolution covers a long period of time (about a century), it is important to analyze the logic of technological development of the economy, both within it and at the junction of industrial revolutions. This more detailed scientific understanding can be made due to the Theory of Technological Paradigms (TP) by D. S. L'vov and S. Yu. Glaziev (see Table 2).

It is noteworthy that chronologically, there are two TP in each industrial revolution. Hence, we can assume the existence of technological continuity of the paradigms within one industrial revolution that provides cyclical changes in the foreign economic policy conducted by leading capitalist countries in the 19th – early 21st century. Let us illustrate these interrelationships. R. Allen identifies 10 macro-inventors of the first (British) industrial revolution (Table 3), whose innovative contribution gave rise to a host of followers – inventors of the "second and third tiers" [Allen, 2017, p. 353].

Today (post factum), the United Kingdom is recognized as the palmary in the formation of prerequisites, and development of the processes of the first industrial revolution. This does not mean that the "queen of the seas" did not have geopolitical competitors claiming global leadership in the emerging capitalist economy.

Table 3

Macro-inventors and their contribution to developing the industrial revolution

Макроизобретатель	Отрасль
Josiah Wedgwood	Ceramics
John Smeaton	Mechanical Engineering
Thomas Newcomen	
James Watt	
Abraham Darby	Metallurgy
Henry Cort	
James Hargreaves	Textile production
Richard Arkwright	
Samuel Crompton	
Edmund Cartwright	

Russian chemist, scientist-encyclopedist and economist, D. I. Mendeleev wrote: "Along with the systematic series of naval and colonial wars (the 17th – 18th centuries) with the Dutch, the British persistently waged the industrial war, and the Navigation Act was the key instrument in the war of this latter kind" [Mendeleev, 1891].

For the economy of the British Empire, no less fateful was the turn of the 18th – 19th centuries – the era of the Napoleonic Wars, and the continental blockade of England initiated by Bonaparte. Thus, at the dawn of the first industrial revolution, key geopolitical competitors sought to use a tough protectionist policy. Meanwhile, history has shown that it was England that was able to most effectively support active innovation processes at home, using political, economic and military means, which ensured its position as a global capitalist leader in the 19th century.

However, in the1840s, England deliberately refuses to categorically protect domestic markets. Did it contradict the interests of the British Crown? No, it did not contradict, and even served its interests in the most direct way. In 1841, F. List wrote, "Only the nation that produces all the items of the factory industry at the lowest prices can establish trade relations with the peoples of all geographical belts and all levels of culture; only it alone can satisfy all their needs, and, for the lack of the latter, elicit new ones, accepting raw materials and foodstuffs of all kinds in exchange. Only such a nation can load ships with many diverse products, which a remote country that is deprived of its own factory industry needs" [List, 2019].

The United Kingdom could both "establish trade relations with the peoples of all geographical belts and all levels of culture" and "load ships with many diverse products"; moreover, it felt the acute capitalist need for this! On this occasion, D. I. Mendeleev wrote: "Manufacturing factory products <…> reached in England the point where it became necessary to be concerned about finding markets for sale of the surplus products" [Mendeleev, 1891].

In other words, according to G. Mensch's concept, the "bundle" of basic technologies mastered the space of the English economy via dissemination of improving and apparent innovations, and reached the natural limit of labor division on a national scale. By the early 1840s, manufacturing new means of production for the domestic market faced a sharp drop in profits [Arrigli, 2006, p. 220]. For a significant expansion of market capacity, which could prevent a drop in the profit norm, British capital was forced to lobby for abolition of protectionist barriers. This led to cancellation of the Cromwell Navigation Act, "the Corn Laws" and a number of other protectionist measures.

Having begun international trade expansion, British capitalism inevitably faced the need for reducing the transport costs of cross-border and even transcontinental trade. By this time, there had already been serious groundwork for solving this problem within the first technological paradigm. So, on the basis of achievements in metallurgy and mechanical engineering (5 out of 10 macro-inventions in Table 3), in 1807, in the United States, R. Fulton built the first commercial steamship, and the first regular voyages across the Atlantic began in 1837 on the steamship built by British engineer I. Brunel. In England, almost simultaneously, steam locomotives appeared on the mine tracks (1813–1814), and after innovations made by engineer J. Stephenson (1825–1833), railways turned into a means of long-distance transport [Gloveli, 2016, p. 290].

Thus, the foreign policy turn of the British Empire towards free-trade became a powerful incentive for expansion of the second technological paradigm (see Table 2). Whereas for the first TP, the driver industries were ferrous metallurgy, mechanical engineering and textile production, for the second TP, they were transport engineering (Table 4) and its attendant industries – ferrous metallurgy and the coal industry, which had received an additional impetus for development.

At the same time, foreign trade expansion is restricted, due to the world market capacity limitations, and increased competition with the business of other countries – ones from "the second tier" of capitalist development. Thus, in 1870, the United Kingdom still ranked first in Europe in terms of industrial production (30.3 % of the pan-European volumes), but Germany, France, Italy and Austria-Hungary demonstrated rather noticeable shares (19.8; 18.9; 10.0, and 9.0 %, respectively). Moreover, in three other countries (except for the UK), the share of industry in GDP is more than 30 %: Switzerland, France and Belgium [Cambridge Economic History …, p. 269]. Of course, we should not forget about the United States of America (where, after the bloody Civil War, foundations of long-term geopolitical leadership were being laid), the Russian Empire (where Alexander II of Russia actively carried out his reforms), and Japan (with its Meiji revolution and the successful catch-up development).

Since the beginning of the British Industrial Revolution (especially, the free-trade policy), England actively exported not only industrial goods, but also technologies of the first and second TPs, as well as institutions of capitalist development. Therefore, on the one hand, exhaustion of the commercial potential of the technologies of the first industrial revolution, and on the other hand, aggravation of capitalist competition of companies representing the leading powers of the world, apparently led to another decrease in the rate of entrepreneurial profit. This is evidenced by the dynamics of the average discount rate in 1857–1906, when, in the European economy, the value of capital fell by more than 1.5 times: from 4.82 % at the turn of the 1850s – 1860s to 3.04 % at the turn of the 1880s – 1890s [Hilferding, 1922, p. 104].

Table 4
Railway and marine steam transport in Europe, in 1821–1876
[Filipenko, 2010, p. 276]

Years	Length of railways, km	Tonnage of steamships
1821	332	32,000
1841	8,591	105,121
1846	17,424	139,973
1851	38,022	263,679
1856	68,148	575,928
1861	106,886	803,003
1866	145,114	1,423,232
1871	235,375	1,930,089
1876	309,641	3,293,072

It is this period when the foreign economic policy of the capitalist leaders is changing: these countries switch from exporting goods to exporting capital to those regions of the world where it can bring the greatest profit, – the era of imperialism begins. Imperialism of the industrial era made relevant a new challenge for entrepreneurs – the problem of remote assets management (especially, industrial), involving the control of business processes in other countries and even on other continents. This task is being solved within the framework of the coming second industrial revolution, its first stage – the third TP (1880s – 1930s).

Technological foundations for the second industrial revolution were laid in the depths of the second or even the first TP. Thus, out of 21 basic technologies of the first half of the 19th century, identified by G. Mensch, at least, 15 technologies belong to electrical engineering and chemical industries – the two leading branches of the second industrial revolution [Mensch, 2019, p. 124]: high voltage generator – 1849, electric pulse inductor – 1846, deep-sea cable – 1866, electricity generation – 1800, insulated wire – 1820, electric arc lamp – 1844, bicycle – 1839, rail – 1835, stretched wire – 1820, puddling – 1824, coke blast furnace – 1796, crucible steel – 1811, steam locomotive – 1824, telegraph – 1833, chamber sulfuric acid process – 1819, pharmaceutical production – 1827, quinine production – 1820, vulcanized rubber – 1852, Portland cement – 1824, potassium chlorate – 1831, photography – 1838.

So, on the one hand, the technologies of the first industrial revolution in the last third of the 19th century had exhausted themselves commercially, and, on the other hand, the technologies of the second industrial revolution were slowly but steadily gaining strength. Which technologies of the latter will primarily interest the business of leading countries of the world (primarily, the UK), burdened with the industry structure of the first and second TP and its corresponding infrastructure? It is logical to assume that entrepreneurs, especially those who own and manage large production facilities, are conservative to a certain extent, and tend not to trust the innovations of "the new century", which require breaking existing technological and organizational structures.

C. Peres describes this situation as follows: "Basic industries of the past technological revolution reap the benefits on a scale, and, most likely, have been exhausted from huge investments in fixed assets. At the same time, these industries have the powerful market structure (oligopoly or almost monopoly) that can provide them with ways of finding new efficient solutions to break out of the trap. Such ways may include mergers, location changes and other original actions in relation to financial capital. <…> However, the processes leading to the next technological revolution are of the utmost importance" [Peres, 2011, p. 58].

As we can see, in this period, investment decisions are mainly aimed at artificially prolonging the life of the technologies applied, and the use of new technologies that make it possible to solve the task. Hence, there is no accidental commercial interest in information and communication technologies of the second industrial revolution at "the end" of the first one: telegraph (1833), photography (1838), transatlantic telegraph (1866), telephone (1881), phonograph/gramophone (1887), international telephone (1910), radio (1922) [Mensch, 2019, pp. 124–128]. In our opinion, for England, France, Germany and other developed capitalist countries, these innovations significantly reduced transaction costs for managing foreign financial expansion related to the sharp increase in capital exports in the pre-war half century (1870s – 1910s).

This did not mean conservation of the technologies of the first industrial revolution, and development of only the information and communication sector based on the technologies of the second industrial revolution. The third TP is also known for serious breakthroughs in electrification, steel production, inorganic chemistry, heavy mechanical engineering (see Table 2). At the same time, at the dawn of development of this technological paradigm, it was information and communication technologies that prevailed, which allowed the leading states to implement the policy of imperialism, characterized by the global domination of financial capital [Hilferding, 1922]. With the constant growth in the trade deficit, nevertheless this policy provided the financial center of the world (England) with a steadily growing positive payments balance (Table 5).

However, the logic of development of the second industrial revolution required radical technological updating of the means of production – the industrial foundation of the economy, which led to the return of protectionist forms of foreign economic policy. About a quarter of the century before, this turn of events was foreseen by D. I. Mendeleev: "There is no need to resume customs protectionism in England, because in all its main industries (for example, navigation, coal mining, machinery production and manufacturing business), it still has no rivals in Europe. But it is already obvious that if America or Russia present a chance of rivalry in these matters, England will again use customs protectionism" [Mendeleev, 1891]. At that time, not only England, but all other leading capitalist countries consistently protected domestic markets from foreign competition.

Meanwhile, the outcome of the global military conflict predetermined the economic leadership of the United States of America. Whereas in 1938, the aggregate share of its main geopolitical competitors (the USSR, the United Kingdom, Germany, France, Japan) was significantly higher than that of the United States (35.0 % versus 23.4 %), in 1950, they were almost equal (29.7 % vs. 28.8 %) [World Economy…, pp. 503–504]. During World War II, the US's industrial enterprises not only did not suffer from bombing raids and artillery fire, but, on the contrary, developed dynamically, ensuring fulfillment of state orders, including those satisfying the needs of allies in the anti-Hitler coalition.

The end of the war could threaten American businessmen with an overproduction crisis and a drop in profit rate.

Table 5
Dynamics of the trade and payments balance of the United Kingdom (1831–1913) [22, p. 276]

Years	Import	Export	Trade	Services	Profit	Current Account
1831–1835	53.6	40.5	–13.1	14.1	5.4	6.4
1851–1855	116.4	88.9	–27.5	23.7	11.7	8.0
1871–1875	302.0	239.5	–62.5	86.8	50.0	74.6
1891–1895	357.1	226.8	–130.3	88.4	94.0	52.0
1911–1913	632.2	488.9	–134.4	152.6	187.9	201.6

It is not surprising that immediately after the end of the war, the United States turned out to be the most consistent supporter of the international trade policy, and initiator of entry into the General Agreement on Trade and Tariffs (1947). War-ravaged Europe, the USSR and Japan were also interested in importing American goods and technologies. Stimulation of foreign trade relations had a powerful impact on developing the means of transportation.

C. Peres drew attention to the fact that "oil refining and the internal combustion engine, invented within framework of the third paradigm, were used mainly in luxury cars" [Peres, 2011, p. 56]. In other words, cars, airplanes, helicopters, as well as the principle of jet propulsion, as innovations took place already within the third TP, largely receiving the impetus for development due to military conflicts. However, they were able to unleash their commercial potential fully, expressed as increasing the speed of cargo transportation and, accordingly, reducing transport costs, only within the fourth TP, by becoming the next natural phase in the second industrial revolution.

The means of transport production became the driver for economic growth in the capitalist world during the fourth TP. The "transport" trend of technological development is confirmed in the statistical data of the *Fortune Global 500 Rating*. Since 1955, the American business magazine *Fortune* has annually ranked 500 of the world's largest companies in terms of revenue [A database of 50 years, Ranking of the largest companies]. The analysis of the industry specialization of the TOP 100 companies in this rating revealed (Table 6) that in 1955, 1965 and 1975, from 23 to 25 enterprises were connected directly with production of the means of transport and their components or with provision of transport services. However, in 1985, 1995 and 2005, there was a noticeable decrease in the number of companies of this type: 22, 14 and 9 out of 100, respectively.

One can say that during this period, the second industrial revolution began to run out of steam, which led to reducing the rate of return on investments in fixed assets. So, in 1974–1995, in the United States, it was about a third lower than in 1949–1973: 13.3 % versus 18.5 % [Klinov, 2016, p. 140]. Perhaps, without knowing it, global business began to reproduce the behavior pattern that conceptually resembled the one to develop in the last third of the 19th – early 20th century, at the junction of the first and second industrial revolutions.

P. G. Shchedrovitsky and V. N. Knyaginin describe this period of development of the world economy as follows, "Industrial and technological development <…> is accompanied by two interrelated processes: rapid aging, and as a result, the depreciation of technologies, on the one hand, and displacement of obsolete and secondary technologies to the regional periphery, where labor and natural resources are cheaper, on the other hand. In the 1970s – 1980s, the so-called flight of factories from industrially developed countries to emerging markets became widespread.

However, developed countries tried to leave in their hands the designing of new technologies, innovations and marketing, and, most importantly, approval of technological standards and consumption standards.

Table 6

Dynamics of the number of companies in the TOP 100 of Fortune Global 500 Rating

Economic sector	1955	1965	1975	1985	1995	2005	2018
Production of means of storage and transmission of information	8	10	10	15	19	19	17
Manufacturing of means of production	42	41	40	35	15	16	25
Production of means of transport and their components, provision of transport services	23	25	25	22	14	9	12

Since the late 1990s, the United States and many other industrially developed countries of the world were faced with a new phenomenon – the withdrawal abroad not only of industrial production, but also in the field of services and intellectual labor. The method of so-called ‘outsourcing of business processes’ was developed <…>, which as one of the most important means for companies to achieve their global competitiveness, provides for the transfer of the set of secondary technological processes to other enterprises. <…> From 1995 to 2000, the industrial sector of the 20 largest economies of the world closed more than 22 million jobs in total (or 11 % of the total number), the significant part of which was transferred to ‘emerging markets’” [Shchedrovitsky, 2019].

The technological basis for such global economic shifts was constantly improving computers connected to the Internet, which made it possible to transmit ever larger amounts of information at ever-increasing speed (the basis of the fifth TP). So, in 1991, the number of computers with Internet access worldwide was about 5 million, in 1996 – 60 million, in 2001 – about 300 million. At the same time, there was aconstant reduction in the cost of electronic equipment and information transmission services. For example, from 1960 through 2000, the price of a personal computer and its peripheral equipment dropped by 1,869 times! [World Economy…, 2003, pp. 36–37].

Analyzing these processes, Yu. V. Shishkov emphasizes the connection between the latest telecommunication and information technologies and effects obtained by entrepreneurs, industries and states: “Information easily overcomes physical barriers and state borders. The global cyberspace is emerging. By making it possible to get necessary information from any distance in real time and make decisions quickly, modern telecommunication systems unprecedentedly facilitate organization of international capital investment, production and marketing cooperation at the corporate level, as well as mutual adaptation of macroeconomic policies of different states at the level of their governments and central banks. The Internet is the powerful accelerator of economic globalization” [World Economy…, 2003, p. 37].

The potential of production technologies in the third industrial revolution began to unfold within the framework of the fifth TP (robotics, CNC machines, etc.), but it was information and communication technologies that formed the basis because they prolonged the life of technologies of the second industrial revolution. At the same time, “the dotcom crisis” in the United States, and especially the global economic crisis of 2008–2009 marked the limits of the latter. The world is on the threshold of the next industrial revolution, called “Industry 4.0” and logically following from the information revolution of the last third of the 20th century, demonstrating the sequence of dissemination of basic technologies from the means of communication sector to the means of production sector and further to the transport sector. The data presented in Table 6 confirm this pattern. Thus, in the second half of the 20th century, the influence of the information and communication sector companies on global economic processes is growing: in the Fortune rating, there were 8 companies out of 100 in 1955, 10 – in 1965, 10 – in 1975, 15 – in 1985, 19 – in 1995. In 1995–2005, the explosive growth of this sector was apparently exhausted (in 2005 – also 19 companies). It is no coincidence that "the dotcom crisis" occurred in 2000. In 2018, only 17 companies of information and communication specialization remained in the TOP 100 of the rating.

On the other hand, after the sharp reduction in the number of industrial giants at the end of the 20th century (in 1985 – 35, in 1995 – 15 enterprises out of 100), at the beginning of the 21st century again, there is the noticeable increase: in 2005 – 16, in 2018 – 25. In our opinion, this indicates a kind of transition of sectoral dominance from information and communication technologies to production technologies of the new industrial revolution.

The convergence of nano-, bio-, info- and cognitive technologies, along with the development of 3D printing, industrial Internet and a number of other innovative trends, should lead to another massive "creative destruction" in manufacturing means of production (the sixth TP). Therefore, at present (as in the period of the first and at the junction of the third and fourth TPs), we observe the desire of leading countries of the world to ensure a critical concentration of the scientific and engineering base on the national territory, and to protect the emerging high-tech domestic industries and their own leadership on the half-century horizon. The trade war between the United States and China, which was unleashed in 2018–2019, confirms our conclusions.

Thus, we can state the relationship of cyclical processes in foreign economic policy and technological development of the economy, expressed in the consistent dissemination of basic technologies in the communication, production and transport sectors (Table 7). Considering the revealed sectoral logic of basic technologies dissemination, it can be predicted that, in about the second third of the 21st century, the driver of the global economy will be the transport system with mass development of drones, electric vehicles and even private space flights. At this time, another round of the WTO activity related to innovations to reduce customs barriers (so-called new free-trade) is likely to be expected.

In his works, Professor S. D. Bodrunov considers the problem of forming the New Industrial Society of the second generation (NIS.2) and noonomy due to changing technological paradigms and industrial revolutions [Bodrunov, 2018a, 2018b]. In a number of his monographs, the author revealed the continuity between the NIS.1 theory by J. K. Galbraith and the NIS.2 [Bodrunov, 2016], as well as the patterns of transition from the NIS.2 to noonomy [Bodrunov, 2018]. Developing S. D. Bodrunov's methodological approach, we will try to offer an objective substantiation for the NIS.2 theory emergence, which logically follows from the concept of a cyclical sequence of basic technologies dissemination and modes of world economic relations presented above. To do this, we will unite in Table 8 chronological sequences of industrial revolutions, technological paradigms, modes of world economic relations and phases of industrial society theories emergence.

We will follow the more common four-phase periodization of industrial revolutions proposed by K. Schwab, bearing in mind that the third industrial revolution is the initial phase of introducing the basic innovation – the microprocessor – into the industrial sector, and the upcoming fourth industrial revolution is the era of mass transformation of industrial and technological processes on an electronic basis. Thus, the third industrial revolution acts as a kind of transition period, similar to the transition period between the first and second industrial revolutions, when the

Table 7

Technological causality of the forms of foreign economic policy of leading capitalist countries in the 19th – 21st centuries

Basic technologies	Technological paradigm	Period	Locomotive sector of the economy	Foreign economic policy of leading countries
Iron smelting, textile machinery, steam engines	I	Until 1840s	Means of production	Protectionism
	II	1840s – 1870s	The same of transport	Free-trade policy
Technologies of the electrical, chemical and steel industries	III	1870s – 1910s	The same of communication	Imperialism
		1910s – 1940s	The same of production	Protectionism
	IV	1940s – 1970s	The same of transport	Free-trade policy
Additive technologies, industrial Internet, robotics	V	1970s – 2010s	The same of communication	Imperialism
	VI	2010s – 2040s (?)	The same of production	Protectionism
	VII (?)	2040s – (?)	The same of transport (?)	Free-trade policy (?)

Table 8

Cyclical patterns of development of basic technologies, world economic relations modes, and industrial society theories

Industrial revolution	Techno-logical paradigm	Period	Locomotive sector of the economy	Mode of world economic relations	Phases of forming industrial society theories
I	I	Until 1840s	Means of production	Protectionism	Industrial society (K. Marx)
	II	1840s – 1870s	The same of transport	Free-trade policy	
I-II	III	1870s – 1910s	The same of communication	Imperialism	Transition period, crisis, “ultra-imperialism” theories
II		1910s – 1940s	The same of production	Protectionism	The New Industrial Society –
	IV	1940s – 1970s	The same of transport	Free-trade policy	NIS 1.0 (J. K. Galbraith)
III	V	1970s – 2010s	The same of communication	Imperialism	Transition period, crisis, “post-industrial society”
IV	VI	2010s – 2040s (?)	The same of production	Protectionism	NIS 2.0 (S. D. Bodrunov)
	VII (?)	2040s – (?)	The same of transport (?)	Free-trade policy (?)	

basic technology – *electricity* – first transformed the infocommunication sphere, and then began to be introduced on a mass scale into the industrial base.

There is hardly any doubt about the fact that in *Das Kapital*, K. Marx gave the political economic description of industrial society. Industrial capital and the proletariat are the main actors in the "dialectical tragedy" of the author of the most popular work on economics in the history of mankind, pushing aside such powerful social figures of any society as bankers, real estate owners, government officials. Marx presents them as "freeloaders" of industrial capital, biting off their share of the surplus value created in industrial production. Marx can be considered to have created the first comprehensive theory of industrial society, being in the time frame of dominance of technologies of the second TP and the first industrial revolution. Technological determinacy of K. Marx's industrial type of thinking was formed in the era when the steam engine transformed industries and transport, and the latter was included by the classicist, as is known, in the sphere of material production that creates real wealth.

The great thinker, who died in 1883, did not live to see the full-scale dissemination of electricity – the key technology of the third TP and the second industrial revolution. Rapid development of the means of communication in the period corresponding to the first half of deployment of the third TP and the transition from the first industrial revolution to the second one gave rise to the temporary crisis of industrial ontology and contributed to the formation of the ultra-imperialism theory, which was put forward by a number of influential left-wing social thinkers (K. Kautsky, R. Hilferding, J. Hobson), and allowed overcoming of the crisis in the imperialist world model that developed at the end of the 19th century, due to collaboration by powerful global corporations. Technological opportunities for concentrating capital, and managing corporate divisions scattered around the world were provided by the achievements of the first information revolution in the late 19th century.

However, in the same period, the logic of technology development contributed to the mass introduction of electricity into industry. Combining electricity and the internal combustion engine led to the second industrial revolution, the beginning of which corresponds chronologically to the second half of the third TP and includes the fourth TP. The economic imperatives for developing the second industrial revolution require a return to protectionism. The massive renewal of the industrial base in leading countries leaves no illusion for the peaceful transition of imperialism into some kind of super-phase, and the relevant theories temporarily recede into the background. Industrial ontology is once again seizing the minds of progressive-minded economists. In the middle of the 20th century, already in the phase of the mature state of the fourth TP, the prominent economist J. K. Galbraith formulates the theory of the New Industrial Society (1967), with its famous components – *technostructure* and *planning system*.

However, the crisis of the 1970s is coming, when, against the background of decreasing efficiency of the fourth TP ("transport"), the new information and communication revolution is gradually unfolding. The pessimism of the intellectuals of that time is embodied not only in the neo-Malthusian reports of the Club of Rome, but also in the next shift in the ontology of economics from industrialism to the service sector. The latter "acquires" the clothing of the post-industrial society theories by D. Bell (1973) and his numerous followers. D. Bell supported the fashion for periodization of technological revolutions, designating creation of computers as the third revolution, which should provide continuous production of information, ensuring social development in all areas. Indeed, in the 1980s, the era of the fifth TP ("information") begins: the return to imperialism in the form of financial liberalization, the Washington Consensus, and globalization theories. Hopes for the approval of the next phase of ultra-imperialism are expressed in the sensational political and philosophical concept *of the end of history by* F. Fukuyama (1990–1992), as well as undoubtedly weaker proper economic concepts of crisis-free managed economic development.

The financial crisis and the subsequent recession of 2008–2009 not only put an end to the illusions of supporters of post-industrial society and globalization as the next edition of ultra-imperialism, but also vividly demonstrated the onset of the fourth industrial revolution, coinciding with the formation of the new – sixth – TP. Once again, in the course of realizing the objective laws of cyclical technological development, the world is abandoning the outdated system of regulating world economic relations (the return to protectionism, the phenomenon of D. Trump). And the most progressive social thinkers are creating theories based on the new industrial ontology.

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