FIBONACCI CYCLES HYPOTHESIS
ГІПОТЕЗА ПРО ЕКОНОМІЧНІ ЦИКЛИ ФІБОНАЧЧІ

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FORMULATION OF THE PROBLEM IN GENERAL

The theory of the cyclical nature of the economy forms a general model of development of the world economy and society in general. By providing content and forms for past trends of Economics development, theory is an effective tool for making predictions about future trends and processes. In practice, such forecasting plays an important role in making strategic decisions. Knowledge (about future events and phenomena gives significant advantages over competitors in the process of achieving the strategic goals. However, the weakness of the theory of economic cycles is the difficulty of defining the boundaries of a cycle, especially about the future. Various theories and hypotheses on cyclical economic development are based on slightly different principles and form different cycles. Therefore, the question of finding objective laws underlying economic cycles is an open problem.

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS AND HIGHLIGHTING OF UNSOLVED ISSUES

The study of economic cycles will start from developments of M.D. Kondratyev, S.A. Kuznets, Cl. Zhuhlyar and J. Kitchyn. The technological side as a cause of cycles will be analyzed based on works of J. Schumpeter, D.S. Lvov, S.Y. Hlazyev. The relationship of technology and economic cycles in the 21st century is outlined in works of O.O. Akayev, O.V. Korotayev, Y.V. Zinkina, Y.V. Bozhevolniy, V.Ye. Lepskiy, I.O. Prohorov.

Fibonacci sequence and its relevance in various fields primarily will be analyzed through studies of the Leonardo of Pisa (Fibonacci) and its historical interpretation by Y.V. Lvov.

Alternative hypotheses vision of economic cycles Fibonacci will be formulated on the basis of works R. Kurtsveyl and S. Lem.

Finding patterns that define the cyclical economy, defining the boundaries of economic cycles and creation of common model of economic development is the goal of this work.

The objectives of the study are:

❑ A brief analysis of works on cyclical economy.

❑ Analysis of the impact of technological development on the economy in the context of the economic cycles.

❑ Research of the connection between Fibonacci sequence of economic cycles.

❑ Description of possible alternatives to proposed model and its critique.

STATEMENT OF THE MAIN MATERIAL

1. The theory of economic cycles

The Russian economist Nikolai Kondratiev by analyzing the statistical data, covering about 100-150 years, concluded that the economic cycles exist [1]. In the long run there are cycles of approximately 40 - 60 years. During one cycle the phase of growth is changed by phase of slowdown [2].

M. Kondratyev identified a number of empirical regularities concerning the long-term economic cycles [3]:

❑ A new wave of growth is caused by significant changes in society, such as major scientific discoveries, changes in the terms of money circulation, strengthening or weakening of certain states.

Various scientists` approaches regarding long-term and short-term economic cycles are described in the article. The reasons that cause economic cycles have been analyzed. Interdependence between economic cycles and technological modes has been revealed. Cycles of society development existence according to the inverted Fibonacci sequence hypothesis has been formed. The use of a new Fibonacci sequence model for future economic processes prognosis has been offered.

У статті окреслено підходи різних науковців щодо виділення довготривалих та короткотривалих економічних циклів. Проаналізовано причини, які зумовлюють циклічність економіки. Виділено взаємозалежність технологічних укладів та економічних циклів. Сформульовано гіпотезу про існування циклів розвитку суспільства відповідно до зворотної послідовності Фібоначчі. Запропоновано застосування новоствореної моделі за послідовністю Фібоначчі для прогнозування майбутніх процесів в економіці.

❑ Most of the social upheavals such as wars, coups occur in the expanding phase of the cycle.

❑ Identification of boundaries of economic cycles is fairly conditional, one of the options below [4]:

- first cycle – from 1803 to 1843;
- the second cycle – from 1851 to 1896;
- the third cycle – from 1896 to 1947;
- the fourth cycle – from 1947 to 1983;
- the fifth cycle – from 1983 to 2018;
- forecast of the sixth cycle – from 2018 to 2060.

Russian-American economist and Nobel laureate S.A. Kuznets (Simon Smith) identified cycles lasting approximately 15-25 years. During these cycles a full update of technologies is occurred. Simon Abramovich called them «demographic cycles» because he linked them to the demographic processes [5], [6].

Kuznets cycles are not contrary to the Kondratieff cycle and complement them, saying in geometric terminology, they are «written in». S.A. Kuznets gives the following series of dates that are associated with depression or stagnation in the United States: 1815 – 1836 – 1853 – 1873 – 1882 – 1892 – 1907 – 1920 – 1929 [7]. Again, the alignment of exact dates is an open question, but observed cycles indicate the validity of the theory Kuznets.

Mid-term cycles, lasting 7-11 years, were identified by French scholar Clement Juglar 8]. These cycles occur because of time lag that occurs when making investment decisions and the creation of new production facilities and capacity and their launch, along with the alignment of the market situation. Juglar cycles, on the conclusion of some scientists, consist of four phases: the phase of recovery, climb phase, the phase of recession and the phase of depression. [9] Juglar cycles are also closely connected with the Kondratiev cycles. The depth of those or other processes that occur according to the Juglar cycle, depends on an appropriate phase, on which exists the economy according to the long Kondratiev cycles. [10]

Juglar gives the dates of crises in some capitalist countries. For example, in the United States these dates are: 1814 – 1818 – 1826 – 1830 – 1837 – 1839 – 1848 – 1857 years [11]. It can be seen that the periods are quite different from each other, because, as in the case of Kuznets cycles, average values were taken to determine the theoretical length of the cycle were taken.

Short-term economic cycles, lasting 3-4 years, were discovered by the British economist Joseph Kitchin [12]. As the Juglar cycles, the Kitchin cycles are associated with a time lag. But, if the Juglar cycles are related to investments in fixed capital, the Kitchin cycles are explained by delayed reaction of managers to changes in market conditions.

As can be seen from the brief description of the economic cycle, Juglar cycles and Kitchin cycles are more functional, they are connected with the human factor, market conditions, and the speed of receipt and processing of information, decision making. Much more difficult is to understand the underlying causes of the existence of Kondratiev and Kuznets cycles.

The fact is that the theory of the long economic cycles is not accepted by all scientists [13]. Practical application of the theory of economic cycles is complicated severity by determination of at least approximate dates of beginning and end of each

cycle. The cyclical development of society and economy through Kondratiev research is simply the result of a specific development objective law (or laws). This is the weak point of the theory of cycling as a consequence of presence requires knowledge of its cause. Search for the following reason (or proof of the fallacy of the theory) is an open question.

Researchers of Kondratiev theory associated physical reasons for the existence of economic cycles with the development of technologies. Even Nikolai Kondratiev himself, seeking the causes of cyclical economy, drew attention to the technological aspect. And J. Schumpeter was able to thoroughly prove reasons - effect relationship between technology and economic cycles[14].

Quality basis for further research of the model of the evolution of society and the economy is the selection of technological structures. Technological structure is a system of interrelated industries, which have only one level of technology and develop synchronously. The term was introduced by Soviet scientists D.S. Lvov and S.Y. Hlazyev [15], [16]. Scientists note that the leading manufacturing system forms the core of technological structure, technological innovations that have formed such productions – «key factors», and industries that above mentioned productions operate in «supporting industries».

There is a system of dominant technologies in the basis of any Kondratiev cycle. That is, technological systems and economic cycles are interdependent and interrelated. Separation of technological structures is also quite arbitrary, because their limits differ significantly according to the works of different scientists. Here is an example of one of the variants of technological structures periodization proposed by T. Makeyeva [17]:

First technological structure (1785-1835 years) - a new technology in the textile industry and the use of water energy are basic.

Second technological structure (1830-1890 years) - the emergence of mechanical production based on steam engine, construction of railways, the development of water steam transport.

Third technological structure (1880-1940) - the development of heavy engineering and electrical industry based on the use of steel, the development of the power industry, financial sector development.

Fourth technological structure (1930-1990 years) – development of conveying production, use of hydrocarbons (mainly oil and natural gas), the development of nuclear energy. A new level of engineering, the development of aviation and space industry.

Fifth technological structure (1985-2035 years) - the development of computer science, microelectronics, the emergence of the Internet, the development of near-Earth space, the development of biotechnology, genetic engineering.

Different periodization is provided by G.G. Malinetsky: first technological structure – 1875-1908 years; fourth technological structure – 1908-1971 years; fifth technological structure – 1971-2011 years [18]. But the essence of the technology of each structure is about the same for different researchers of this problem. Civilization goes through different technological stages step by step.

On the one hand the development of technologies gives the economy new stimuli for development, the formation of new industry, labour productivity; entrepreneurs, who introduce them, receive considerable advantages over competitors. But on the other hand, the rise in the economy stimulates the next stage of technological progress. Interdependence of technological base and the economy points to the fact that as the technologies lead to changes in economic, so does the development of economic stimulate the technological evolution. This process is well described by philosophical laws of dialectics:

❑ significant funding of technology sooner or later is embodied in the result;

❑ old and new technologies are in unity and simultaneously oppose one another as part of an economic cycle (or phase of the economy);

❑ a new economic cycle is formed based on technologies that will be destroyed by it to form a new technology that will put an end to this economic cycle.

So, the question is whether the technology causes cyclical economy, or vice versa, recalls the dilemma of philosophy: what came first the chicken or the egg. Coming back to the economic interpretation, it is reasonable to conclude that the development of technology and the cyclical nature of the economy, and related socio-cultural, political and other changes in society are subject to a single law of a general nature and are the same process.

Technological structure as well as Kondratiev long cycles is the consequences of this common law development. Therefore, despite empirical evidence of technological structures, it is difficult to specify their precise boundaries without knowing the causes and patterns that underlie them (similar to the economic cycles).

2. Fibonacci cycles hypothesis

Let us consider the shortcomings of the theory of economic cycles In search of a common development model (and the related concept of technological structures).

It is reasonable to conclude that the duration of the Kondratiev waves is a non-permanent value on the basis of works of S.Y. Hlazyev, S.P. Kapitsa[19], L.E. Grinin and other authors. The empirical evidence of this fact is the acceleration of the development of civilization in the second half of the XX and the beginning of the XXI centuries. Thus, Hlazyev indicates that it will take only 8 years from the origin of the technologies to their widespread in technological structure 6. While in the first and third structure this period was about 15-20 years, and the fourth – fifth – from 10 to 15 years [15], [16]. The evidence of acceleration of development are many other processes – the number of obtained patents, published scientific works, inventions and other. Even without such evidence, the accelerated development and changes in society can be seen with the naked eye. Therefore, we would venture to suggest that in the absence of global catastrophes or serious obstacles to development, each successive structure of technology and the economic cycle will be shorter than the previous one.

When considering the duration of economic cycles and technological structures, we note that periodization starts only after the end of the XVIII century. The first structure of technology according to Malynetskiy started in 1772 after the first industrial revolution, Kondratiev and Kuznets start the periodization of economic cycles from 1803 and the first economic cycle «begins» in 1815 year according to Juglar.

But economic relations and trade emerged much earlier. As early as the tenth century BC the first assigning economy crisis started. Because of «Neolithic revolution,» which lasted from the tenth to the third century BC, gathering and hunting began to give way to agriculture and ranching. During this period private property, division of labour, surplus goods emerge, giving way for trade and economic relations of primitive archaic [20], [21].

The era of gathering and hunting is qualitatively different in technologies and relations from the period of primitive agriculture and animal husbandry, and availability for different periods of core technologies and relationships around them indicates the existence of technological structures at that times. Obviously, they lasted much longer than 50 years. Such archaic technological structures can be distinguished in the prehistoric periods of the stone age, bronze age, iron age. Technologies have passed through many stages.to the XVIII century (the period of the first technological structure). And they lasted from tens of thousands of years to a few hundred years. Each of the next period, absorbing all technological inventions and discoveries of the previous one, was shorter and brought the society to a qualitatively new level of development. Without a doubt, this question is for more than one study.

Even if we doubt the existence of primitive technological structures and neglect periods after them – the antiquity, the Middle ages with the typical for those times technology and economies, it is necessary to notice, that the Renaissance period in Europe, which began in the mid XV century, after the period of the Middle ages and continued until the end of the XVII century has enough signs of a technological structure.

The Renaissance of science and art, the Great geographical discoveries led to the «boom» of inventions and discoveries. The science in the contemporary sense, including modern economic thought arise in this period [22]. Decomposition of the feudal system and the emergence of early capitalism also fall in this period, and the development of mercantilism emerges. M. Berdyaev indicates that civilization is transformed into «technogenic» one [23]. The analysis of this period once again points to the interdependence

and complementarity of the processes in the world, since the Renaissance is a historical period of development of civilization, technological stage, the period of development of the world art stage in the development of philosophical thought, the period of development of economy[24],[25],[26].

The duration of this process stage (let's call it «technological way minus the first level») was apparently much higher than 50-60 years. Harmoniously the Renaissance, its duration was approximately 210-240 years.

A similar stage of development of civilization was also education. Anti-absolutist and feudal attitudes in society contributed to the flourishing of capitalism. The technological breakthrough based on inventions and scientific research G. Galileo, I. Newton, R. Hooke and others. Academies were formed [27]. Needless to repeat that stage was also comprehensive. Therefore, the researchers investigated it as a variety of scientific directions.

The upper limit of the Enlightenment can be considered the French Revolution and the Industrial revolution [28], [29]. The industrial revolution took place a long time, so its boundaries stretch from the end to the beginning of the XVIII XIX century. Thus, this process stage (conditionally – «technological structure zero»), lasted 120-150 years.

It is reasonable to conclude that the rate of development of society is constantly growing. Therefore, each subsequent stage is shorter than the previous one. This statement is not entirely compatible with the theory of the long Kondratiev cycles and the concept of technological structures, as Kondratiev cycles are approximately equal, as technology structures. Therefore it is necessary to analyze the essence of this paradox.

Firstly, it should be noted that empirical evidence of technological structures and economic cycles researchers cover the XIX-XX century.

Secondly, the length of economic cycles and technological structures vary from 40 to 60 years, i.e. there is some disagreement about the length of this or that way of life cycle. Moreover, different scientists have different differences.

It can be assumed that the stages of social development in the XIX-XX centuries, regardless of whether it was a factor taken into account by accelerating the development should not significantly vary from the rate of 40-60 years.

However, in the second half of XX - beginning of XXI centuries, economic cycles and technological structures are already difficult to «squeeze» in such average characteristics as 40 to 60 years. Let us outline the last passed stage of social development. The economic crisis of 2008-2009 is the signal of the end of the previous stage. At this time from the technological side portable microelectronics started to be massively distributed, rapid growth of volumes of accumulated data, massive distribution of social networks, mass-market electric cars began to emerge [30], private companies on space exploration entered the market (SpaceX, Virgin Galactic, Orbital Sciences Corporation), there have been significant advances in genetic engineering, nanotechnology and more. The D-Wave Systems Company is very similar in repeating the scenario of Apple Corporation, offering the market the first quantum computers. Such things as crowd funding, crowd sourcing and crypto currency emerge in the economy [31], [32]. These changes indicate a certain stage of social development and the beginning of a new one.

Let's go back to the recent past and determine the actual start of the aforementioned period. If we consider the economic aspects, the major shock to the global economy was the collapse of the Bretton – Woods system, which was based on the «gold standard»[33]. In parallel with this event there was a great oil crisis in 1973 [34]. The technology changed simultaneously with the economy. The computer made in the mid 70-'s by Steve Jobs and Steve Wozniak founded the era of personal computers (interestingly, iPhone in 2007 became the leader of a new round of development of electronics) [35], in 1975 Paul Allen and Bill Gates created «Microsoft»[36], since the beginning of 1970-ies American Silicon valley becomes more significant. A qualitative transition in various fields of science and technology happened. According to some researchers the fifth technological structure started – the era of computers and telecommunications. [37].

Thus we distinguish certain periods of development, which lasted from 1973-1975 years 2008-2009. Its duration is approximately 35 years.

Let us present the sequence of all selected periods to determine the acceleration of development:

...210-240,120-150, classical technological stages for a period of 40 to 60, 35...

Making an analogy with mathematical sequences, you can make the assumption that the resulting sequence is reminiscent of the Fibonacci sequence, which go in the opposite direction.

It is well known that the Fibonacci sequence consists of numbers, each of which is the sum of the previous two:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, 1597, ...

The sequence is named after a medieval mathematician Leonardo of Pisa, known as Fibonacci [38]. Various phenomena in nature and society according to the researchers are developing in this sequence. For example, velotaxis (restorepalette) in plants is associated with this sequence. Sunflower seeds, pine cones, flowers are often placed according to it [39]. The sequence is observed in the genetic structures of organisms, in elementary particle physics, spatial distribution of the Egyptian pyramids [40].

However, not all processes in nature and society are subject to this order. There is the large amount of speculation, fraud and manipulation of facts around this theme. There is a number of stories when the sequence was associated with mysticism, "creature of God, the magic numbers [39]. Therefore, it is very important not to develop a "perpetual motion machine" and not give in to the euphoria of the universality of the sequence, which is just a particular case. On further investigation, it is important to separate the grain of truth that can link the sequence with the cycles of development of the society. That is, to make the Fibonacci sequence to "work" on the creation of a model of development, and not Vice versa. And in the case of ineffectiveness of this approach, it is necessary to immediately give way to alternative solution to the problem.

Firstly, an important rationale for the prevalence of sequence in natural phenomena is its simplicity. Secondly, it is obvious that any rational development involves the optimal use of resources and energy. It is believed that this most simple and economical way to "solve problems" in nature is the Fibonacci sequence. This simplicity can be achieved repetition of the same successful reception, which leads to the formation of fractal structures and processes [41].

Let us determine which prerequisites can cause the development of society in line with the Fibonacci sequence:
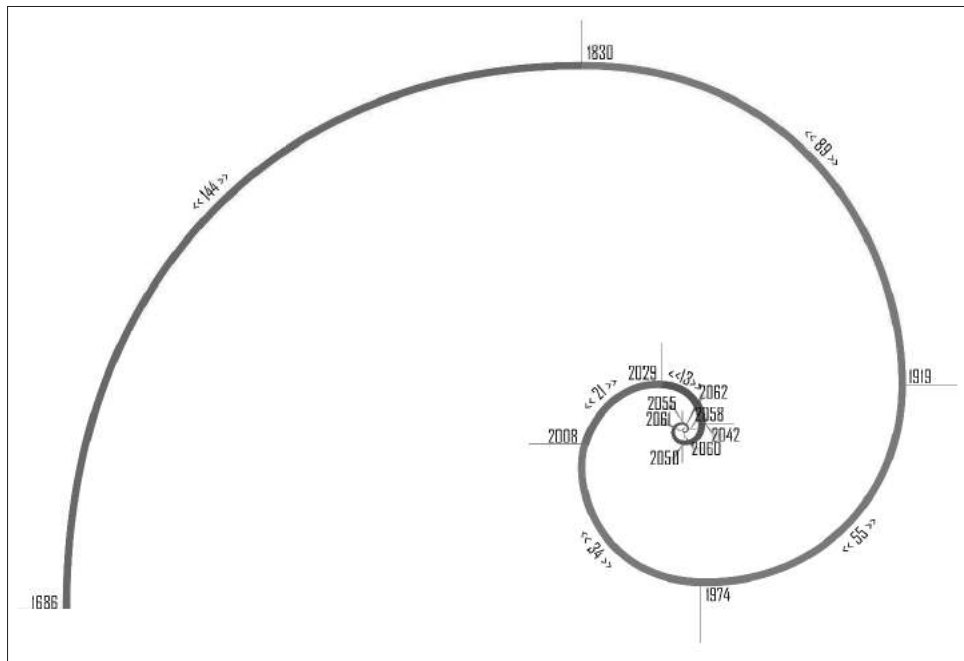
1. The driving force behind the development of civilization is the human factor. People in the process of meeting their needs: basic-food, housing, safety, but first of all, self-realization, to address new issues-creative, scientific, such that generate interest in the new, determine the movement of society. People seek to improve the conditions of its existence and, at the same time, to satisfy their desire for knowledge about the world. That is, people at the same time are the driving force of development and the goal of this development.

2. The results of human activities, part of which becomes the tool of improvement and acceleration of the process, form in the process of self-realization and improvement of conditions of existence. And this should include not only factors of production, but any tools that can be used by a person to realize their goals and needs. This should include facilities, the core of which is a scientific and technological advances and system knowledge of mankind, civilized relations system, including how the combination of existing tools. It should be noted that the whole system of assets (tangible, intangible, spiritual) created to improve the conditions of personal existence and for personal purposes, originated by the thirst for knowledge and self-realization, is the tool of civilization development.

3. At the beginning of the development of human civilization, people had no other tools than themselves as the basic instrument. All the rest of the instruments, even spiritual values we assign to the original (auxiliary) instruments of civilization development. Therefore, the speed of development of civilization depends on human interaction with all auxiliary development tools. The initial stage it is expedient to start from a position "0", from the time when the person has not created any supporting tools of civilization development.

4. It was the period when the person has created a set of auxiliary development tools, which is conditionally equal to "1". Then for the next stage of development of civilization it had was a combination of the underlying instrument (itself) and a set of tools, the level of "1", which helped to speed

Fig. 1. **Model of civilization development according to the hypothesis of "Fibonacci cycles"**

up development and create a set of tools of "2". Transition to new levels of development of auxiliary tools by Fibonacci sequence can be the easiest and most economical principle of development. By the analogy to velotaxis, imputation of development of each of the next stage will be equal to the sum of the previous two.

5. Since it is impossible to determine the unit of measure for ascertaining the level of civilization development (in the abovementioned two paragraphs we highlight them conditionally), we can use only indirect values or the effects of civilizational processes. The result is the length of this or that stage, the value of which is determined on the basis of empirical research. The latter indicated the reduction of each next stage in accordance with the countdown sequence of Fibonacci numbers. In the broadest sense of the above situation, it is obvious that the speed of development of civilization is directly proportional to the magnitude of the level of development of this or that stage (auxiliary civilizational instruments), and the duration of this or that stage is inversely proportional to the level of its development (its auxiliary instruments).

Thus, let us denote the model of civilization development, which is based on the countdown sequence of Fibonacci numbers. The reference period on the basis of which we shall build the rest of the model will be the period 1974-2008, and we will also take the stages of development of civilization

Table 1. **Comparison of timeframe periods based on the Fibonacci sequence, the concept of technological structures and Kondratiev long economic cycles theory.**

Periods for model-based sequence Fibonacci	Technological structures (according to G.G. Malynetsky, V.E. Lepsky, and I.A. Prokhorov)	Kondratyev cycles
144 years stage – 1686-1830	First structure – 1772-1825	First cycle – 1803-1843
89 years stage – 1830-1919	Second structure – 1825- 1875	Second cycle – 1851-1896
	Third structure – 1875-1908	Third cycle – 1896-1947
55 years stage – 1919-1974	Fourth structure – 1908- 1971	Fourth cycle – 1947-1983
34 years stage – 1974-2008	Fifth structure – 1971-2011	Fifth cycle – 1983-2018
21 years stage – 2008-2029	Sixth structure – 2011-2060	Sixth cycle prognosis – 2018-2060
13 years stage – 2029-2042		
8 years stage – 2042-2050		
5 years stage – 2050-2055		
3 years stage – 2055-2058		
2 years stage – 2058-2060	Seventh structure – 2060- ?	
1 years stage – 2061		
1 years stage – 2062		

during the XVII-XIX centuries into account (**Fig. 1**). The model, which is graphically illustrated in a spiral of Fibonacci, shows the duration of the different periods, as well as the acceleration of the development. The kinks of a spiral show years, where the transition from one period to another approximately happened. Stages from 1830 to 2008 coincide with periods of "classical business cycle" and technological structures, 2008-2029 – the stage at which the society is nowadays. And the periods from 2029 to 2062, which are quite short, are called "accelerated development zone" or "zone of turbulence".

Let us compare the obtained periods for newly created model with economic Kondratiev cycles and technological structures (**Table 1**).

As can be seen from table 1, the first technological structure and the economic cycle refer to the end "144-year" period of development for the newly created model. The second and third structures` duration approximately coincides with the "89-year" period. The fourth and fifth technological structures coincide with "the 55-year-old" and "the 34-year periods respectively. That is, the thesis, indicated earlier in the study, that in XIX - XX centuries the stages of human development did not differ materially from 40 to 60 years rate is confirmed. Especially, if to pay attention that the previous steps for the new model took hundreds of years.

Let's remind, that according to the model for the Fibonacci sequence society is on "the 21-year development period. That is, if it is true, civilization faces another systemic crisis and the transition to a new stage in the area in 2029. After that, all subsequent stages will be quite short, and be – 13, 8, 5, 3, 2, 1, 1 respectively ("zone of turbulence"). That is, changes in society will be so fast that adaptation will become increasingly difficult (see Fig. 1). Given the way the world is recovering from the economic crisis of 2008-2009, it is possible that after 2029, the situation in the economy will be like one continuous crisis with temporary improvements. Unpredictable changes in that case will be expected in the global political-legal, socio-cultural environment. On the other hand, the rapid development of science and technology will lead to a sharp transitions from one technological mode to another, which will allow humanity to solve a lot of problems of various character. Wise use of technological base could eliminate all the negative consequences of crises in the economic, socio-political, ecological and other environments.

It should be noted that in the 2062 comes a certain point, after which the forecasting according to Fibonacci model in the proposed version is impossible. Economic cycles, technological structures, stages of development in different spheres of civilization will change instantly. What this would mean in fact is extremely difficult to assume, probably, impossible. Driving forces of civilization and objectives outlined earlier will change fundamentally. Yet let us dare to assume that a person as a driving force and purpose of civilization development will somehow change and improve its nature or create new driving forces and goals that give rise to a new model of civilization development.

3. Criticism of hypotheses about Fibonacci economic cycles. An alternative vision

A model for the development of civilization according to Fibonacci sequence is dynamic. That is, it considers that the public does not develop linearly and the rate of changes is growing. For today there are enough facts, many of which are mentioned in the study that the development of the society occurs with certain acceleration, the density of events is constantly growing and every next period is shorter than the previous one. The model indicates the interdependence of processes, without singling out some of them (technology in determining the technological structures) as primary.

If a development of civilization model according to Fibonacci sequence is valid, it forms the foundation for prediction of many things. So it is critical to note the weaknesses of the hypothesis to continue its research:

1. The assumption about the transition from one stage of development to another must be confirmed (or refuted) due to research of different areas of society. The abovementioned model is constructed on the basis of a systematic vision of the problem, but with lack of specific studies. Consequently, it is necessary to recognize the lack of sufficient evidence to move the model from the phase of hypotheses in the phase of theory.

2. It is rather difficult to evaluate critically the fact that periods of civilization after 2029, technological structure, and economic cycles will respectively be 13, 8, 5, 3, 2, 1, 1. That is, that the number of changes that have occurred, for example, from the middle of the XV till the end of XVII will be equivalent to the changes within one year 2061.

3. Fibonacci sequence model, as well as Kondratiev theory allows certain deviations during the setting of periods limits. Thus, defining the limits of "34-year" period is rather arbitrary, since the beginning of it accounts for 1973-1975 and ending – 2007-2009. Such inaccuracy of limits can be a tool for artificial adjustment of the facts to the necessary conclusions.

The fairest critic of the proposed hypotheses is time. It is easy to calculate that the middle of "the 21-year phase" will be in 2019. And if, in the end of 20-ies of the XXI century there will be a systemic crisis in all spheres of human life, the hypothesis will have sufficient proof. Otherwise, it is necessary to draw a conclusion about the inefficiency of the model.

Firstly, based on the fact of the reduction of certain periods of development, let us emphasize that technological structures and economic cycles will increasingly coincide in time. The reduction of the long Kondratiev cycles will lead to their coincidence by length with the Kuznets cycles. The acceleration of the reactions in those or other changes in society will reduce time lags. Accordingly, the cycles of Juglar and Kitchin will also be reduced.

The first alternative model for the Fibonacci sequence is the classical Kondratiev model with an adjustment for dynamism. That is, the long economic cycles are valid only on the basis of acceleration. This model is a model-consequence, which can only state the fact of cycle and stages changes. It is impossible to say what exactly leads to the development acceleration and what are the factors and rates of this acceleration according to it. It is impossible to make any prognosis without knowing the rate of acceleration.

The second alternative to the Fibonacci sequence models is the absence of any development algorithm. We should not exclude such a variant that clear patterns in the causes and consequences of change of epochs may not exist. That is, one period of civilization is characterized by a linear development, the other – cyclic, another – exponential, or can develop completely erratically. In this case, the construction of the model of development is not possible.

As an alternative vision, we can mark the achievements of F. Engels. He pointed out that science moves with a speed proportional to the mass of knowledge gained from previous generations. And beginning from the XVII century, the development of science is characterized as the square of the distance in time from its initial point. Similar ideas have been formulated by V.I. Vernadsky. That is, there is an "exponential development of science" model, which can be logically linked with civilization development [42], [43]. Today this concept is actively supported and developed by R. Kurzweil [44]. Any value that is expanding exponentially will grow faster if it becomes larger. In nature, an example of exponential development may be a colony of bacteria that grows exponentially until the resources for its growth run out. This fact proves that not everything in nature develops in the Fibonacci sequence, as some scholars think.

Despite highlighting only some of the alternatives to the Fibonacci sequence development hypothesis, it can be argued that there are a lot more. Therefore, this article by offers even more new challenges for future research by providing possible answers to long-standing questions.

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