Transformation of the structure of the timber industry complex on the path to new industrialization

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Abstract. The article shows a study to assess the structure of the timber industry complex of Russia in the pioneering days of a new industrialization. It is a radically new stage of scientific and technological progress that has no historical analogues in the degree of influence on human civilization. New industrial technologies, possessing enormous potential for changing the direction of technological development, at the same time have ambiguous social and environmental consequences. The timber industry complex is one of the most important and interesting objects for research, since the products of the industry are distributed throughout the world and play an important role for the economies of all countries. In developed countries, the forest industry complex accounts for about 10% of the total industrial production. Wood is an important type of raw material. Even considering the competition from new technologies and materials, the proportion in the structure of the global gross domestic product is almost not reduced. The fundamental problem of assessing and predicting the effects of new industrialization based on technological transformation using quantitative indicators forms the need to create a multisigmoidal innovation cycle for changing the structure: from obtaining new fundamental knowledge to their practical use.

1. Introduction
The global crisis, which began in 2008 and lasted several years, has led to the fact that it was necessary to revise the existing traditional model of globalization. The developed countries began to work in this direction. It led them to the understanding that the possibilities of traditional information and communication technologies (ICT) began to lag behind the new economic conditions with constant economic growth. It should be noted that the process of re-industrialization started in 2010. It is the reverse process of industrialization that needed to be changed. This became possible only through the introduction of advanced information technologies in all the areas of product life cycle management. Global changes began to occur in the very essence of the industrial basis of the entire industry, which led to a change in the foundations of the industry, an era of new industrialization, which was the large-scale introduction of the breakthrough technologies of the future.

Advanced manufacturing technologies are based on three pillars of industrial development: design and organization of production processes; transition to new materials and methods of working with them; transition to "smart environments and networks". The priorities of the Strategy of the scientific and technological development of the Russian Federation for the next 10-15 years indicate the transition to advanced digital, intelligent production technologies, new materials and design
technologies, which requires an assessment of the need and possibility of changing the structure of the Russian timber industry.

Consideration of the issue of new industrialization in the research of domestic and foreign authors is quite new, due to the complexity and versatility of the merger of two significant provisions of the study of the digital economy and the forest complex in the context of trans-industry of its industry as independent objects of study. In the literature review of the works of foreign authors in the field of studying the digital economy [1] it is considered as a driving force of economic growth, which can lead to significant economic shifts and affect the whole areas of business, the labour market and the way of life of people [2]. Another point of view is presented by the author of Bahl, who is considering the issues of measuring digitalization, failure to achieve targets in this area, as well as strategies for government agencies and business representatives in order to promote the development of the digital economy [3]. The author does not provide a specific definition. Instead, a distinction is made in the work between “exploiting” digital technologies and “existing” thanks to them. Cognizant analysts, by contrast, seek to separate types of activities that simply use digital technology and those for which digital technology is the basis of the fundamentals [2, 3].

The management of the development, introduction and spread of the digital economy in relation to the environmental protection sphere has been studied extensively by the authors all over the world. However, a comprehensive analysis with a detailed comprehensive assessment of structural changes of the timber industry complex in the pioneering days of a new industrialization has not been reflected in the works of domestic and foreign authors. Therefore the development of information and analytical tools to assess changes in the structure of the timber industry complex that requires a transition to a new industrialization has a high importance and relevance for the development of science. The purpose of the study is to assess the modernization of the development structure of the timber industry, taking into account the use of the latest digital economy mechanisms for forecasting the new industrialization of the timber industry as the basis for changing its structure in order to transform digital economic development.

2. Methodology

New industrial technologies, possessing enormous potential for changing the direction of technological development, at the same time, have ambiguous social and environmental consequences [4]. And this becomes another challenge requiring the development of risk management mechanisms for the technological transformation of the forest complex on the basis of forecasting its development.

Constant monitoring, coordination and forecasting of the development of different types of socio-economic systems allow implementing the concept of sustainable development - both within local territories and global ones - with the least amount of negative effects.

The scientific problem addressed by this scientific study is to assess the modernization of the structure of the timber industry complex with the application of the latest digital economy mechanisms [5]. It penetrates through the latest advances in information technologies that create a platform for creating new conditions for their functioning, developing management mechanisms technological transformation of the timber industry complex in order to make competent management decisions [6]. The main task of the research is to create a multi-sigmoidal innovation cycle: from obtaining new fundamental knowledge to their practical use in the conditions of the digital economy of Russia. It improves its further development along with the effective use of scientific and technological potential. It is necessary to modernize the timber industry complex with traditional production branches and changes in the structure of consumption and the strategizing of the development of the timber industry complex [7] in the conditions of the emergence of the digital economy against the background of the penetration of information technologies into the industrial sectors of Russia [8].

Modernization of the timber industry complex of Russia with its traditional manufacturing sectors really requires the transformation and introduction of new mechanisms of the digital economy against the background of the penetration of information technologies into the industrial sectors of Russia [9].
However, it is necessary to assess its current state for analytics, modeling, forecasting and planning changes in its structure, taking into account the formation of a new industrialization.

The main objectives of the study are aimed at:
- Development of performance indicators for monitoring the current state of the forest industry based on them;
- Assessment of industrial development as a basis for improving the position of the Russian timber industry complex in international trade, striving for maximum efficiency of operation and the increment of external competitive potential.
- Elaboration of the industrial development of the timber industry complex during the transition to advanced digital and robotic technologies in order to increase revenues, profits and competitiveness in the domestic and global markets.

The study is also aimed at solving new problems of environmental management in the context of transition to new industrialization. Here the forest industry complex of Russia with its diversity of forest resources, natural and climatic zones and applicable managers, information technologies of logging, timber processing and navigation systems has been chosen as a research object [10].

The scientific novelty of this study is based on the formation of the methodological foundations and principles for constructing forecasts for the new industrialization of the timber industry complex. It is a basis for changing its structure using the end-to-end digital economy technologies to obtain more accurate analysis, prediction, evidence and meaningful extrapolation to identify opportunities for sustainable growth in the competitiveness of forest sector sectors Russia and further digital economic development.

The practical significance and lack of knowledge of digital market development and behavior has driven the need and timeliness for developing models and methods for introducing digital economy mechanisms into industrial technological development of forest enterprises. It can be based on a set of adapted fractal methods analysis, the theory of fuzzy sets, wavelet analysis and the theory of cellular automata [11]. The importance and relevance of this problem determined the purpose and objectives of the study. It is possible to obtain satisfactory results in the complex process of building one-parameter forecast only in the complex of synergistic [12] and classical approaches [13].

The change of the linear paradigm, the transition to the methods of nonlinear dynamics, the global progress of computer technologies and the study of complex systems with the help of application software packages enables to create a multi-sigmoidal innovation cycle: from obtaining new fundamental knowledge to their practical use in the conditions of the emergence of new industrialization of Russia.

We propose to use the methods of statistics and the differential approach, the reproduction and network method with the development of the existing today to implement the goals and objectives of the study. It determines the novelty. The study uses economic-mathematical and econometric modeling methods, as well as matrix methods with the development of existing ones, which emphasizes the novelty of this scientific research.

3. Results
The multisigmoidal innovation cycle of changes in the structure of the timber industry complex (from obtaining new fundamental knowledge to their practical use) describes several simultaneous production, economic, innovative, and engineering processes at once. The method of its construction enables to graphically analyze the time dependences of such economic indicators [14], such as the volume of shipped products, the volume of the domestic market, exports and imports, the structure of enterprises of the timber industry complex. It also helps to analyze the effectiveness of production of innovative goods by type of economic activity and to evaluate financial result. All this can be made by the means of sigmoidal function superposition.

Figure 1 represents the results of the analysis of the time dependencies for the above indicators: under the letter (a) sigmoidal functions overlap each other when describing the transition from $E=1$ to
$E=2$ in the time period from 2015 to 2016 and further transition from $E=2$ to $E=3$ in the time period from 2015 to 2016. Then the transition was from $E=3$ to $E=4$ until the end of 2018.

We express this dependence in the equation (1):

$$E(t) = 1 + \frac{2 - 1}{1 + \exp\left(\frac{6t - 3(2015 + 2016)}{6}\right)} + \frac{4 - 2}{1 + \exp\left(\frac{6t - 3(2016 + 2018)}{6}\right)}.$$ 

\(t\), years

\(t\), years

\(2015\ 2016\ 2017\ 2018\ t,\ years\)

\(0\ 1\ 2\ 3\ 4\ E(t)\)

\(2015\ 2016\ 2017\ 2018\ t,\ years\)

\(0\ 1\ 2\ 3\ 4\ E(t)\)

\(2015\ 2016\ 2017\ 2018\ t,\ years\)

\(0\ 1\ 2\ 3\ 4\ E(t)\)

\(2015\ 2016\ 2017\ 2018\ t,\ years\)

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\(2015\ 2016\ 2017\ 2018\ t,\ years\)

\(0\ 1\ 2\ 3\ 4\ E(t)\)

\(2015\ 2016\ 2017\ 2018\ t,\ years\)

\(0\ 1\ 2\ 3\ 4\ E(t)\)

Figure 1. Graphical results of the analysis of temporal dependencies $E(t)$ by means of a combination of sigmoidal functions: (a) – the overlap of sigmoidal functions on each other; (b) – transitions of varying degrees and directions of the process; (c) – short-term transition; (d) – long-term transition process; (f) – the imposition of a short-term transition process on a long-term transition process.

The graph in figure 1b reflects 4 transitions of varying degrees and directions of the process. The first decline $E$ in 2015 goes down from 4 to 2 then goes up in 2016 from 2 to 3. After some stagnation
there is a sharp decline from 3 to 1 in 2018, and during 2018 there is an increase to the middle of the year, and then steady stagnation.

The following figure 1c reflects a gradual growth starting from 1 in 2015 and at the end of 2018. It has already reached the “4” mark:
- rise 1: from \( E = 1 \) to \( E = 2 \) in the period from \( t_{s1} = 2016.5 \) to \( t_{f1} = 2016.5 \);
- rise 2: from \( E = 2 \) to \( E = 3 \) in the period from \( t_{s2} = 2016.5 \) to \( t_{f2} = 2017.5 \) years;
- rise 3: from \( E = 3 \) to \( E = 4 \) in the period from \( t_{s3} = 2017.5 \) to \( t_{f3} = 2018.5 \) years.

The imposition of a short-term transition process on a long-term transition process occurred in the graphical time dependencies, shown in figure 1d and 1e. This indicates that the long-term process provides an increase in value \( E \) by three points in both cases. This indicates that in both cases the long-term process provides an increase in the value of \( E \) by three points, and there was an additional increment by one in the short term on the chart under the letter (d), and under the letter (e) – by 0.7.

We write the multisigmoidal expression for this case.

\[
E(t) = 1 + \frac{2.5 - 1.2}{1 + \exp\left(\frac{6t - 3(2015 + 2017)}{4}\right)} + \frac{4.7 - 3}{1 + \exp\left(\frac{6t - 3(2017.5 + 2018.9)}{0.6}\right)}. \tag{2}
\]

The creation of a multisigmoidal innovation cycle is very significant in terms of describing a wide range of innovation processes associated with the development of industrial enterprises in the field of the timber industry. The use of multisigmoidal functions in solving problems of building a model of priority directions for the policy of innovative development of enterprises of the timber industry complex is sufficiently reasonable. It is due to the high degree of complexity and consistency of the approaches used in studying changes in the processes of complex systems filled with economic meaning and mathematical description.

Forecast of the multisigmoidal innovation cycle of changing the structure of the timber industry complex (from obtaining new fundamental knowledge to their practical use from 2019 to 2024) compiled on the basis of the analyzed dependencies of economic indicators (table 1). Firstly, the financial result and loss have reached constant values since 2015, and then remain virtually unchanged, as shown in figure 1. At the same time, profit starts to increase sharply in 2017 and then continues to increase, and for a rather long time (figure 1a). The duration of the main process was 12 years, starting in 2012 and has significant amplitude of about 40%. At the end of 2018, you can observe a decrease in the curve, superimposed on a slight increase.

### Table 1. Analyzed dependencies of economic indicators.

| Year | FR, billion rub. | NP, billion rub. | L, billion rub. | SFR, billion rub. |
|------|-----------------|-----------------|----------------|------------------|
| 2019 | 100.5           | 91.7            | -8.9           | 26.39            |
| 2020 | 149.6           | 127.3           | -22.4          | 26.38            |
| 2021 | 198.7           | 162.9           | -35.9          | 26.37            |
| 2022 | 247.8           | 198.5           | -49.4          | 26.36            |
| 2023 | 296.9           | 234.1           | -62.9          | 26.35            |

An almost threefold increase in earnings is expected in the next 5 years. Such a sharp rise in sigmoidal dependence is caused by a sharp jump in profits from 20.5 to 56.1 billion rubles in the period from 2017 to 2018.
4. Conclusion
The results of the study substantiate the need to transform the Russian timber industry complex into digital space with the study of new trends in new industrialization and digitalization of production and management processes. These strengthen the position of the socio-economic development of the forest complex in the future. Present-day processes force us to anticipate the future directions of industrial development [15], to predict and plan socio-economic, scientific and technical development of the timber industry complex as the object of this study. The forest complex of Russia is in dire need of infrastructural transformation. Digital transformation for transition from stagnant conditions to sustainable growth of competitiveness in the Russian and global markets is also an urgent task [16].

This issue is of particular importance for the Russian economy. Digital and robotic technologies are used as the basis for enriching the new, more accurate content of the comprehensive study of industrialization and digitalization as the main regulators tied to time and situations of analysis, planning and forecasting of the multisigmoidal innovation cycle of changing the structure of the timber industry complex (from obtaining new fundamental knowledge to their practical use).

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