



Modeling of Factors of Development of Cyclic Economy at the Meso Level

Irina V. Zhukovskaya^{1*}, Marina V. Shinkevich¹, Anzhelika V. Vasilyeva², Maxim V. Zinchenko³, Natalia V. Berezina⁴, Natalia F. Popova⁵

¹ Department of Logistics and Management, Kazan National Research Technological University, Kazan, Russian Federation

² Department of Economy and Management of Organization, Amur State University, Blagoveshchensk, Russian Federation

³ Department of Economic Theory and Public Administration, Amur State University, Blagoveshchensk, Russian Federation

⁴ Department of Finance, Credit and Economic Security, Chuvash State University, Cheboksary, Russian Federation

⁵ Department of Legal Regulation of Economic Activity, Financial University under the Government of the Russian Federation, Moscow, Russian Federation

Received: 18/12/2019

Accepted: 19/03/2020

Published: 20/02/2020

Abstract

The article presents modeling of factors of development of a cyclical economy at the mesoscale. The relevance of the article is due to the fact that the issues of the development of a cyclical economy and its influence on trends in the industrial sector have not yet been fully resolved and require additional study and systematization of the factors that determine it. The purpose of the article is to summarize theoretical approaches to managing the cyclical economy at the mesoscale and to analyze its implementation. As the main research methods, the article used methods of description, comparison, generalization, analysis and synthesis, descriptive statistics, and regression analysis. Based on a synthesis of theoretical approaches, the basic principles of managing a cyclical economy are identified. The article provides a systematization of the trends of cyclical economics and industrial production for the mesoscale of the economic system. The obtained results of the regression analysis allow calculating the growth of industrial production based on the elasticity factors of the model using indicators of the cyclic economy, which can be used to develop environmental monitoring programs and projects for introducing the fundamentals of the cyclic economy in industrial enterprises.

Keywords: Cyclical economy, Industrial production, Meso-economic system, Gross value added, Ecology, Rational use of natural resources, Modeling

1 Introduction

The mega economics entering the active phase of the formation of a new technological structure posed new urgent problems and tasks for the scientific community, the solution of which cannot be found under the conditions of the linear model currently in force in most economies. Given the shortage of material resources, volatility in the market for raw materials prices, significant costs for warehousing and freight forwarding services in the production and sale of products, the potential of a linear economy will soon reach its limit [1].

These issues are becoming relevant not only for mega and macroeconomic systems, but are also of paramount importance for the development of mesoeconomics, as an integral part of the national economic system. As an example of trends in the development of a cyclical economy, the experience of the mesosystem (regional industrial complex) can be considered, where the problems of resource conservation, achieving a balance of production, environmental and economic subsystems are considered as key to achieving sustainable development of the mesoeconomics [2]. The purpose of the article is to generalize theoretical approaches to the issues of managing the cyclical economy at the mesoscale and to analyze its implementation for the mesoeconomics. The objectives of the article are:

- A generalization of theoretical approaches to the concept of a cyclical economy and the principles of its management;
- Analysis of trends in the main aspects of the development of a cyclical economy at the mesoscale;
- Building a regression model of the influence of the parameters of the cyclical economy on the growth of the formed gross value added of the industrial sector of the mesoeconomic system.

The problems of forming sustainable economic relations are addressed in the studies of the following authors: S.K. Sahu & K. Narayanan [3], C. Carpenter [4], M.E. Narandja, S. Howes and B. Fattahi [5]. The issues of the management methodology for achieving the sustainability of the functioning of the mega and macroeconomic economies are the subject of works: Y. He and B. Lin [6], K. Andriuskevicius [7], N. Edmonson [8], Zh. Wang [9] and others. Thus, the cyclical economy can be characterized as a system, the achievement of sustainable development of which is dictated by the balance and unity of the social, environmental and economic subsystems, which also include issues of material and technical production and consumption of products (Figure 1).

Corresponding author: Irina V. Zhukovskaya, Department of Logistics and Management, Kazan National Research Technological University, Kazan, Russia. E-mail: irina.zh072@yandex.ru.

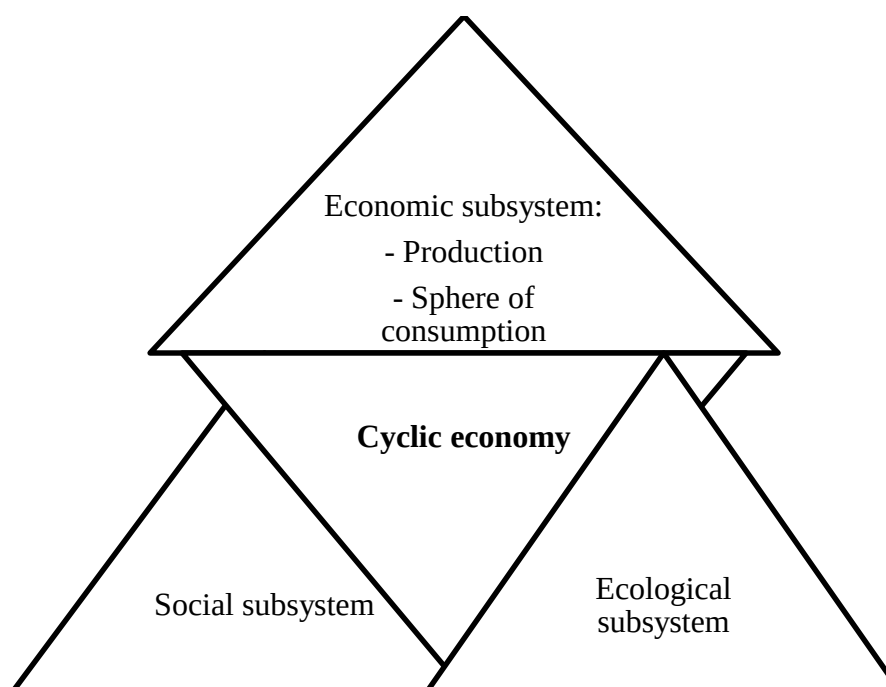


Figure 1: The structural components of a cyclical economy

Achieving these goals becomes possible due to the solidification of business models of key partners in industrial and economic activities, as well as consumers in the process of use and disposal of products [12]. Thus, the basic principles of managing a cyclical economy are: the unity of all subsystems of society, open business models, cooperation between manufacturers, suppliers and consumers throughout the chain of creation, use and disposal of products, the introduction of innovative technologies in production and management.

2 Research Methodology

The methodological basis of the study was the methods of comparison, description, descriptive statistics, correlation and regression modeling, visualization method. Based on the methods of description and comparison, an analytical analysis of the assessment of the influence of national culture in economic systems from the point of view of the formation and development of key components of a cyclical economy is presented.

Using the correlation and regression analysis, the influence of the parameters of the cyclical economy at the mesoscale on the growth of gross value added of the industrial sector is determined, which allows using the obtained model for forecasting trends in the industrial complex and mesoeconomics in general, which can be applied in the development of programs and projects for improving the competitiveness of mesoeconomic systems.

The visualization method allowed us to give a graphical representation of the regression model, clearly demonstrating the influence of indicators of the cyclical economy on the formation of gross value added, which allows us to visualize this relationship.

3 Results and Discussion

We believe that the type of national culture that prevails in economic systems and influences the formation of a model of thinking is important in matters of the development of a cyclical economy. Moreover, in the context of the globalization of economic systems, intercultural interaction

plays a paramount role in the supply chains of final products in the development of a cyclical economy.

National culture is one of the most documented levels of culture in the literature of authors of different directions, the cultural dimension, fueled, in some cases, by an ethno-historical perspective. In this sense, Kulholn and Strodtbek, two anthropologists who developed the very first proportionate approach to culture, drawing inspiration from the works that philosophers and sociologists have used for centuries. Their works include studies of human nature, the relationship between man and nature, good and bad, time and space.

Edward T. Hall also focuses on communication features found in cultures based on four dimensions, namely, the context of communication, space management, the relationship to time and the structure of community flows. We can also note the study of Hofstede (1980-1991), which focuses on the collective characteristics of citizens of the country. This author considers culture as a kind of collective programming of the brain, consisting in distinguishing people from different nations. G. Hofstede's model uses 5 key characteristics of national culture: the distance of power, the level of individualism (collectivism), the predominance of male or female principles, the desire to evade the uncertainty of the external environment, and the orientation toward long-term relationships.

The distance of power characterizes the degree to which less influential members of organizations and institutions (for example, families) accept and expect that power is distributed unevenly.

Individualism is the degree to which people feel independence, not interdependence, as members of larger whole. Individualism does not mean selfishness. This means that individual choices and decisions are expected. Collectivism does not mean intimacy. This means that a person "knows his place" in life, which is determined socially. With a metaphor from physics, people in an individualistic society are more like atoms flying in a gas, while in collectivist societies they are more like atoms fixed in a crystal.

Masculinity is the degree to which the use of force is supported in society. In male society, men must be tough. Men must be from Mars, women from Venus. Victory is important for both sexes. The quantity is important, and the large is beautiful. In female society, gender is emotionally closer.

The desire to avoid uncertainty is connected with the tolerance of society to uncertainty and uncertainty. Prevention of uncertainty has nothing to do with risk prevention or the following rules. This is due to anxiety and distrust in the face of the unknown and, conversely, to the desire to have constant habits and rituals and to know the truth. Long-term orientation deals with change. In a culture oriented to a long time, the basic idea of the world is that it is in motion, and preparation for the future is always necessary. In a culture focused on a short time, the world is essentially the way it was created, so the past provides a moral compass, and sticking to it is morally good. Let us present an assessment of supply chain management (SCM) in a cyclical economy in terms of the characteristics of the national culture that dominates economic systems (Table 1).

It is worth noting that an increasing number of terms are used by individuals and organizations that appear to be more appropriate, comprehensive or advanced than DRM. Such terms include demand chain management (to distinguish it from the type of management in which “supply” begins and controls the chain of actions), as well as value chain or value chain management.

Supply chains can be managed as a whole through a dominant member or, alternatively, through a system of partnerships that require well-developed cooperation and coordination. Therefore, the formulation of supply chain goals is not an easy task, since all partners must agree on the choice of indicators, the definition of indicators and target values. The existing performance indicators used by most companies have a number of problems that prevent them from effectively measuring the overall performance of the supply chain. Participants in the supply chain should begin by jointly identifying winners and executors of orders for the supply chain, as they provide the intended direction for control actions to improve supply chain performance.

Despite globalization spanning the global economy, enterprises and individual entrepreneurs doing business

abroad face a serious problem of cultural differences, which play a key role in international economic relations. Changes in the structure of the 20th century international industrial organization, which aroused research interest among economists, also led to a significant amount of work in business literature. Indeed, many factors that influence the restructuring of industry are related to business. Examples include assembly line innovation and implementation, scientific management, modularity, lean manufacturing, and on-time production. While terminology such as “task trading”, “vertical specialization”, and “production sharing” is used in economic literature, business literature focuses on “supply chains.” This is combined with conditions from political economists and development theorists, which include “value chains”, “global product chains” and “global production networks”. Of these, the supply chain provides the most relevant perspective for a practicing business. Networks of firms are considered from the point of view of the main company, and the supply chain ontology takes various dimensions to orient the company with its network environment (for example, direct extended supply chains, horizontal levels or degrees of separation, and vertical structures within each tier). For too long, many companies have shown tunneling in their approach to doing business in emerging markets such as China, India, Brazil, and Russia. The Chinese are very hardworking, but they admire the objective, effective way of doing business in the West. Chinese managers improved their managerial skills, and many traveled to western countries for short-term management training.

However, in China there is a young hardworking generation that is ready to educate and learn on its own. They are proud to work for foreign firms and adapt to new challenges. China is developing railway ties with European countries, it should be noted that trains go to other countries. Thus, any political instability can greatly affect transcontinental freight transport. In order to successfully manage international railways, a logistics service company has to deal with various railway operators, customs regimes and laws. Brazil has traditional supply chain management, which involves some fairly standard trade-offs.

Table 1: Distinctive characteristics of supply chain management in a traditional and cyclical economy

Parameter Characteristics	Traditional Management	Supply Chain Management in a Cyclical Economy
Specifics of Inventory Management	Each participant in the supply chain independently reduces inventory	Reduction of stocks of resources, semi-finished products and finished products is carried out jointly
Creating a value chain	The desire to reduce the costs of a local enterprise	Cost optimization not for individual participants in the creation of value, but for the entire chain
Contract Planning Horizon	Short-term Contracts	Strategic Partnership
Information flow management and monitoring	Concentration of efforts on current transactions	Long-term planning
Joint planning system	Based on one-time transactions	Long-term contractual relations
Unity Management Philosophy	Missing	Unified
The number of suppliers in the network	Large in order to reduce the risk of supply disruption	Minimum in order to strengthen coordination
Distribution channel management	Minimum or none	Mechanism of economic and ethical coordination required
Reward and risk sharing system	Individual for each company	Joint distribution
The speed of operations	Longer with a focus on the formation of stocks in case of instability in demand.	A system of flexible response to demand, minimization of products in the chain

Achieving savings in the provision of services, and direct sales. The true winners of the supply chain are those who can break these standard compromises with unconventional approaches. This is certainly the case, except that:

1) Brazil's geographic space and population as a whole mean that the distribution of goods is fragmented across many channels.

2) Taxes are high compared to logistics costs, and tax policies are complex and unstable. Companies often make taxes decisive when making key decisions in the supply chain.

3) Demand for many products is concentrated in the last week of the month. This leads to chaos in warehouses and increases transportation costs.

These difficulties in the aggregate create problems that are not similar to those encountered in any other market, developed or developing. A review and comparative analysis of possible approaches to assessing the development of informal institutions (Figure 2) used in the works of Russian scientists is carried out. The analysis indicates that in the process of supply chains in Russia they use a high score of power distance and the desire to avoid uncertainty, strict rules, regulations and / or laws for managing flows in comparison with other countries. Thus, the Russian economy has the highest value of the uncertainty avoidance index - 95 points out of 100. For comparison: the value of this indicator in Brazil was 76, India - 40, China - 30. One of the highest is the power distance indicator - 93 points out of 100. It should be noted that in all developing countries under consideration, this indicator was high: in China - 80, in India - 77, in Brazil - 69, which allows us to talk about the unification of common features in the interaction between higher and lower levels of government in a hierarchy ical structures. The individualism index for the considered national cultures was insignificant, the lowest value was noted in China - 20 points out of 100, then - in Brazil - 38, in Russia - 39, India - 48. A characteristic feature of Chinese national culture, in contrast to other economic systems under consideration, was the dominance of

the masculinity index, the value of which amounted to 66 points out of 100. For comparison: in India - 56, in Brazil - 49, in Russia - 36.

Thus, summarizing, the following features of the Russian national culture should be pointed out: a high imperious distance in the governance structure and a desire to avoid uncertainty, which indicates a closed and traditional economic system, a weak susceptibility to dynamism, innovation, which, as a result, complicates the perception of the new managerial paradigms - a cyclical economy.

Some researchers believe that we are entering a new era in socio-economic history. For management, this means that traditional, proven ways of doing business must change and new principles must be adopted. Openness, partnership, resource sharing and global operations are key principles in this new era. Similar principles also play an important role in supply chain management.

1) National culture has a significant impact on the success of cooperation between companies in the supply chain.

2) Companies integrated into international supply chains should: understand what foreign employers expect from them, feel free to discuss emerging cross-cultural problems with their superiors, and strive not only for inter-functional or inter-organizational, but also for inter-cultural coordination, that is, coordination between corporate and national culture.

3) Countries where strong individualism and a confrontational approach prevail may be in a less favorable position. In this case, the chances of success of a partnership in the supply chain can be increased by creating a national culture focused on cooperation and using tools that will help determine the goals of the partnership and its optimal "depth".

4) The company measures and controls labor costs and production results, stimulates the growth and improvement of production, and also improves the structure of reproduction and distribution of resources.

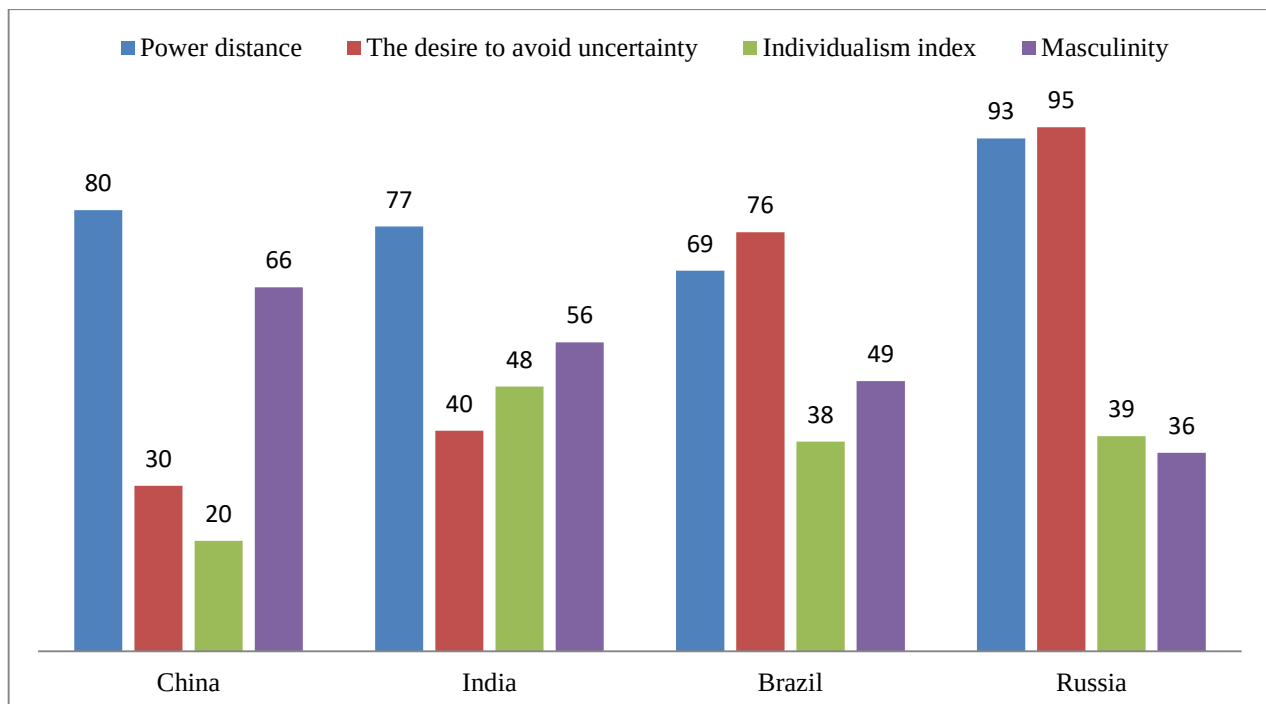


Figure 2: Supply chain assessments

Issues of the development of a cyclical economy are receiving more and more attention in the management of mesoeconomic systems. One example of this management initiative is regional industrial complexes, presented as mesosystems. About 50% (48.2% in 2018) of the generated gross regional product accounted for industrial production, while this indicator increases annually [11].

Let us analyze the main indicators of a cyclical economy using the example of a mesosystem. A positive trend is characterized by fixed capital investments aimed at protecting the environment and rational use of natural resources, which increased from 4058.5 million rubles in 2014 to 5820.9 million rubles in 2018 (an increase of 43.4%). Over a five-year period, water losses during transportation decreased from 61.65 million m³ to 51.88 million m³ (decrease by 15.8%); water use - from 724.46 million m³ to 663.39 million m³ (decrease by 8.4%); discharge of polluted wastewater - from 439.42 million m³ to 296.19 million m³ (a decrease of 32.6%). Positive dynamics is also noted in the volume of reverse and sequential water supply, where the value of the indicator increased by 202% - from 4635.05 to 5569.33 million m³. However, against the background of positive improvements in the introduction of a cyclical economy, negative trends were also observed associated with an increase in emissions of atmospheric pollutants from stationary sources by 34.1% in 2014-2018; freshwater withdrawal from natural water sources and reforestation for the indicated period practically did not change. At the same time, the capture and neutralization of air polluting substances emanating from stationary sources decreased by 8.2%. The share of energy resources produced using renewable energy sources in the total volume of energy resources decreased from 8.7% in 2014 to 6.8% in 2018 (Table 2) [13]. Thus, despite the introduction of the fundamentals of a cyclical economy, there are negative trends and inconsistent trends in its formation and development on the meso-control of the management of the economic system, which complicates the transition to a sustainable economy. One of the negative factors holding back the development of a cyclical economy is the excessive environmental impact of the industrial complex, which is

characterized by annual growth trends. The total number of pollutant emissions into the atmosphere increased from 617.5 thousand tons in 2014 to 768.4 thousand tons in 2018 (an increase of 24.4%), while the increase was noted as due to emissions from mobile sources and stationary [13].

In 2018, hydrocarbons (including volatile organic compounds) accounted for the largest share in the structure of pollutant emissions in gross atmospheric emissions in 2018 - 56.1% (45.4% in 2014), Carbon monoxide - 17.2% (26, 4%), nitrogen oxides - 12.1% (12.2%), sulfur dioxide - 8.7%

(10.3%), solids - 4.6% (4.6%) (Figure 3) [13]. The analysis of the dynamics of the main indicators of industrial development in the cyclical economy showed that the growth rates of the main macroeconomic indicators - the gross value added of the industry, the balanced financial result, investments in fixed assets exceeded the growth of indicators of the cyclical economy - investments in fixed assets aimed at protecting the environment and rational use natural resources and current costs for environmental protection (average growth rate was 114.6%, respectively, 1 22% and 100.1% versus 109.4% and 99.4%). In addition, the ratio of environmental protection costs to the balanced financial result of industrial enterprises was characterized by a decrease, so if in 2014 the value of the indicator was 7.8%, then in 2018 it was 3.4%. The share of investments in fixed assets aimed at protecting the environment and rational use of natural resources in the total investment of industrial enterprises increased from 1.9% to 2.7% for the analyzed period [10, 11]. To identify the dependence of industrial production development trends and indicators of a cyclical economy, we use the method of regression analysis. As a dependent variable, we propose to take the gross value added of the industrial sector, independent ones - investments in fixed assets aimed at protecting the environment and rational use of natural resources and current costs for protecting the environment.

Table 2: The main indicators of the cyclical economy of the mesosystem (for example, a regional industrial complex) (Environmental protection in the Republic of Tatarstan, 2019 [13])

Indicator	2014	2015	2016	2017	2018
Investments in fixed assets aimed at protecting the environment and rational use of natural resources, million rubles	4058,5	6574,6	4566,6	5225,6	5820,9
Current expenses for environmental protection, million rubles	12973,5	9961,8	10861,3	11755,3	12676,4
Emissions of air polluting substances from stationary sources, thousand tons	293,6	293,6	338,3	285,9	393,6
Capture and neutralization of air polluting substances emanating from stationary sources, thousand tons	426,6	437,3	495,1	463,2	391,6
Freshwater withdrawal from natural water sources, mln. m ³	786,66	775,12	792,32	784,30	768,38
Water losses during transportation, mln m ³	61,65	53,65	48,92	47,96	51,88
Water use, mln. m ³	724,46	720,40	744,19	692,28	663,39
Volume of reverse and sequential water supply, mln. m ³	4635,05	4794,36	5251,51	5347,77	5569,33
Contaminated wastewater discharge, mln. m ³	439,42	382,48	325,21	319,71	296,19
Reforestation, ha	2580	2128	1923	2839	2406
The share of energy resources produced using renewable energy sources in the total volume of energy resources, %	8,7	10,3	7,8	9,5	6,8

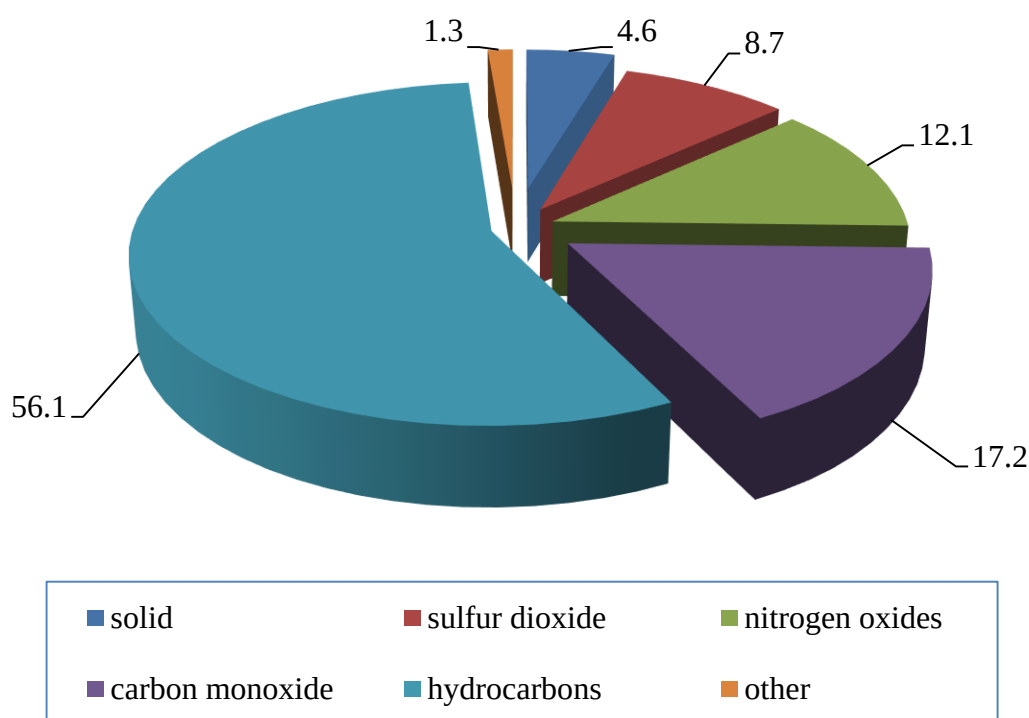


Figure 3: The share of pollutants in gross atmospheric emissions for 2018 (in percent)

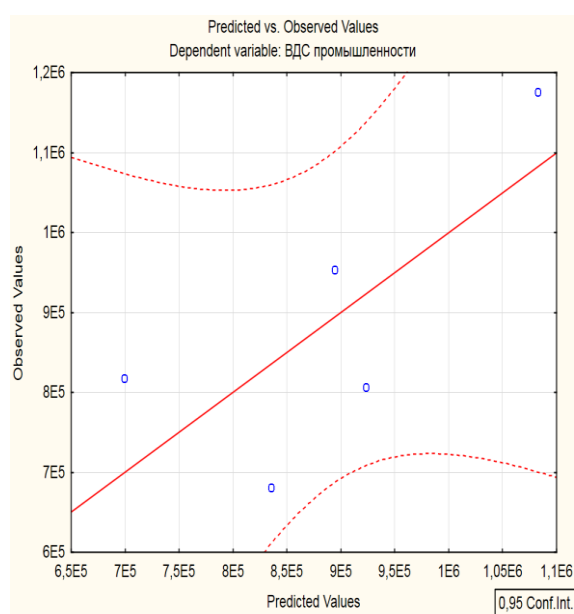


Figure 4a: Observed and predicted values of the GVA of the industry

Based on the simulation, the following linear regression equation was obtained:

$$Y = -1133 + 157,5 \times X_1 + 102,5 \times X_2,$$

Where Y is gross value added of the industrial sector (million rubles); X_1 is fixed capital investments aimed at environmental protection and rational use of natural resources (million rubles); and X_2 is current environmental costs (million rubles). Thus, the results of the regression analysis confirmed the hypothesis about the positive impact of indicators of the cyclical economy on the development of industrial production of the mesoeconomic system. Moreover,

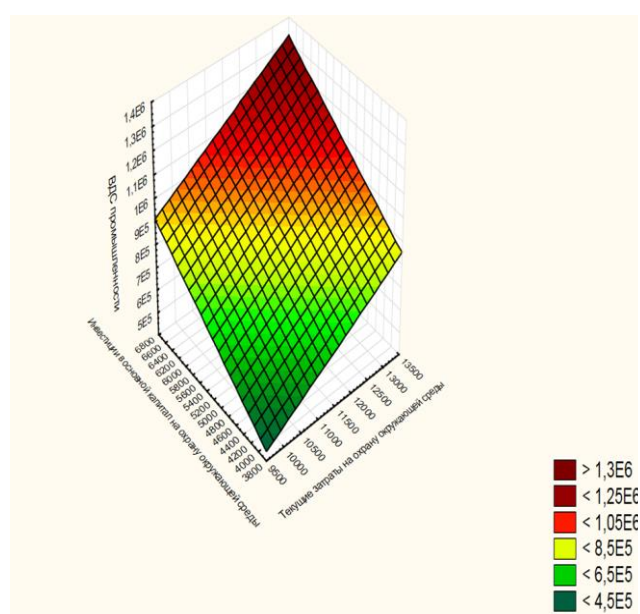


Figure 4b: The surface diagram of the parameters of the regression model

a greater impact is noted in the investment component - for example, an increase in investments in fixed assets aimed at protecting the environment and the rational use of natural resources by 1 thousand rubles will ensure an increase in the gross value added of industry by 157.5 thousand rubles. The presented regression model is statistically significant: the coefficient of determination of the model was 60%, there is no correlation in the residuals of the model, the average value of the residuals is zero (Figure 4.a-b). The obtained results of the regression analysis allow calculating the growth of industrial production on the basis of the elasticity factors of the model using indicators of the cyclic economy, which can be used to develop environmental monitoring programs and projects for

introducing the fundamentals of the cyclic economy in industrial enterprises.

[12] Environmental protection in the Republic of Tatarstan. Statistical compilation. Kazan: Tatarstanstat. 2019.

4 Conclusion

Thus, an analysis of the trends of the cyclical economy and the industrial sector at the mesoscale showed their divergence, which impedes the achievement of sustainable development of the mesoeconomics and the national economic system as a whole. Based on the regression analysis, the hypothesis about the positive influence of the cyclical economy on the growth of the formed added value in industry is confirmed, which can be used in developing programs and projects for introducing the fundamentals of the cyclical economy at the mesoscale.

Ethical issue

Authors are aware of, and comply with, best practice in publication ethics specifically with regard to authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests and compliance with policies on research ethics. Authors adhere to publication requirements that submitted work is original and has not been published elsewhere in any language.

Competing interests

The authors declare that there is no conflict of interest that would prejudice the impartiality of this scientific work.

Authors' contribution

All authors of this study have a complete contribution for data collection, data analyses and manuscript writing.

References

- [1] Krasnova OM, Kudryavtseva SS. The transport complex in the economy of the Republic of Tatarstan. *Economic Bulletin of the Republic of Tatarstan*.2014;1:27-37.
- [2] Kudryavtseva SS, Neganov KK. Scientific and technical potential of Russia as a factor of economic growth in the knowledge economy. *Economic Bulletin of the Republic of Tatarstan*.2016;2:61-65.
- [3] Sahu SK, Narayanan K. Environmental Certification and Technical Efficiency: A Study of Manufacturing Firms in India. *Journal of Industry Competition and Trade*.2016;16(2):191-207.
- [4] Carpenter C. Innovative developments in Caspian Republics' oil and gas production. *Journal of Petroleum Technology*.2016; 68(1):42-45.
- [5] Narandja ME, Howes S, Fattahi B. The role of soft skills in a challenging environment. *Journal of Petroleum Technology*.2015;67(9):102-108.
- [6] He Y, Lin B. Time-varying effects of cyclical fluctuations in China's energy industry on the macro economy and carbon emissions. *Energy*.2018;155:1102-1112.
- [7] Andriuskevicius K. Opportunities and challenges of value creation through merger and acquisitions in cyclical economies. 20th International Scientific Conference "Economics and Management (ICEM)". Kaunas, Lithuania: *Procedia Social and Behavioral Sciences*.2015;213:764-769.
- [8] Edmonson N. *Technological Foundations of Cyclical Economic Growth: The Case of the United States Economy*. Piscataway: Transaction Publishers. 2009.
- [9] Wang Zh. Green Manufacturing Based on Cyclical Economy in China's Rural Poverty-Stricken Areas. 15th International Conference on Industrial Engineering and Engineering Management, Zhengzhou, Peoples R China.2008; pp. 921-925.
- [10] Shinkevich AI, Barseghyan NV. Ways to improve the efficiency of the organization of production processes in petrochemical enterprises through the use of automation systems. *Russian engineer*.2019;4:48-51.
- [11] The Republic of Tatarstan in numbers. Statistical compilation. Kazan: Tatarstanstat. 2019.