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The Theory of Innovation and Innovative Development. AI Scenarios in Russia.

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The Theory of Innovation and Innovative Development. AI Scenarios in Russia.

Abstract – This article explores different scenarios of implementing artificial intelligence (AI) in Russia. The relevance of the research and the range of problems addressed in it consist in the fact that Russia is not fully realizing the potential of innovative economic development. AI can accelerate the innovative development of Russia's economy, but it entails the risks of its destabilization and therefore requires further research. This article contributes to the theory of innovation, thereby specifying the logic of the optimization of innovative development and the optimal scale in a strategy of risk management. The effectiveness of the digital modernization of Russia's economy based on AI will be remarkably high. The index of global competitiveness achieves maximum value (7 points), increasing by 1.52 times. The innovation index of the economy grows 1.15 times. The unemployment level will rise 1.62 times, and the level of cybersecurity will decrease 6.52 times. Both advantages from the implementation of AI and risks of digital modernization of the Russian economy are determined. The significance of the research consists in the application of the offered method for determining the optimal intervals of AI usage in Russia. The key conclusion that can be drawn from the research is the justification of the need to promote the modernization of the Russian economy on the basis of AI with a view to accelerating its innovative development until 2024. The consequences of the research are involved with the improvement of practices of public regulation of the innovative development of the Russian economy by promoting the dissemination of AI according to recommendations proposed by the authors.

Keywords: artificial intelligence (AI), technology, cybersecurity, economic development, risk management, Russia.

JEL Code: O3, O14.

1. Introduction

Breakthrough technologies and technological progress are now widely seen in the economy—e.g., nano-industry, telecommunications. One of them is artificial intelligence (AI), which creation and dissemination may have a different influence on socio-economic systems. On the

one hand, AI will lead to the unprecedented growth of efficiency and rationality due to complex and precise decisions that are inaccessible for a human. On the other hand, AI is a rival for human intellect, so its implementation could be accompanied by public dissatisfaction and protest. Today breakthrough technologies are especially popular, and it is possible to fully automatize production in the real economy under the control of AI. The working hypothesis of this article consists of the fact that implementation of AI in the economy is related to ambiguous consequences—positive and negative—so it is essential to determine the corresponding limits of its application.

The relevance of the research is that the modern global economy is characterized by the active competition among countries in the field of innovative economic development. Russia is not fully realizing the potential of innovative economic development. This is proved by the official statistical data contained in the dataset of the Institute of Scientific Communications (2020), according to which Russia ranked 46th in the world in 2020 (at year-end 2019) in terms of the WIPO Innovation Index (37.62 points), 43rd in terms of the Global Competitiveness Index, 4.0 World Economic Forum (66.7 points), and 42nd in the IMD World Digital Competitiveness Ranking (70.406 points). AI can accelerate the process of innovative development of the Russian economy, but entails the risks of its destabilization and therefore requires further research.

We determine the AI scenarios, the preferable scale, and develop a strategy of risk management in this process. After this instruction, a review of literature is presented, and the research methodology is described. The results are then presented in the form of three main conceptual sections. Section 1 shows causal connections of the development of AI in Russia. Section 2 describes scenarios of development of AI in Russia. Section 3 presents the strategy of risk management in the development of AI in Russia until 2024.

2. Literature Review

Demand for AI and perspectives of its potential directions and application are discussed in Bhattacharya et al. (2019), Bhowmik et al. (2019), Cramer (2018), Gu et al. (2018), Ivanov et al. (2018), Salehi and Burgueño (2018), Wudhikarn et al. (2018), and Yadav and Singh (2019).

Actual issues of functioning and development of economic systems, as well as opportunities and means of modernization on the basis of breakthrough technologies, are studied in the works Arampantzi et al. (2018), Ashimova et al. (2014), Bogoviz (2019), Sergi et al. (2019), Sergi and Popkova (2019), Buergin et al. (2018), Popkova (2019), Popkova et al. (2019), and Yue and Li (2016).

The role and value of Russia's economy, as well as existing and potential vector of its development are determined in the works Inshakova et al. (2016), Kail et al. (2017), Morozova et al. (2018), Popkova (2017), Popkova et al. (2018), Popkova and Sukhodolov (2017a), and Popkova and Sukhodolov (2017b).

Modern experience and prospects of innovative development of the economy, including Russian economy, are described in details in papers by Berber and Lekovic (2018), Bilińska-Reformat et al. (2019), Bikse et al. (2018), Pogodaeva et al. (2018), Polukhina and Rukomoinikova (2018), Vepo do Nascimento Ter et al. (2020).

The literature showed that the AI had been studied only fragmentarily thus far. From the practical point of view, AI is studied indirectly within the general tendencies of modernization and the innovative development of the economy. There is a deficit of factual data on the character and level of influence of AI on socio-economic systems. Narrow and targeted studies of perspectives of implementation of AI in the economy are absent, and this gap in the existing scientific knowledge is to be filled by this article.

The modernization of Russia's economy is a strategic priority. Russia has enough resources (human, financial) and is peculiar to a prominent level of development for the successful creation of AI and its implementation into production. Quantitative and qualitative scenarios of development of AI are formulated, and perspectives of the optimization of this process are determined. In the third stage, the strategy of risk management in AI in Russia is explored and explained.

3. Materials and Methodology

AI is determined as a flow-through digital technology within the Program "Digital economy of the Russian Federation", adopted by the Decree of the Government of the RF dated July 28, 2017, No. 1632-r, together with big data, technologies of virtual and alternate realities, e.g., Robototronics (Government of the RF, 2018).

The most exciting manifestations of economy's digitization are its global competitiveness (as expected, digitization should stimulate its increase and strengthening of the country's positions in the global arena due to optimization of business processes), level and rate of innovative development (being the leading production technologies, digital technologies are to ensure innovation), social consequences (as expected, digitization will lead to the replacement of traditional jobs with automatized business processes, which will lead to the growth of unemployment), and consequences in the cyber security (it is considered that digitization of economy leads to growth of its dependence on the telecommunication infrastructure and makes it more vulnerable to attacks of cyber criminals).

For the complex study of the influence of the process of digitization on the socio-economic system (in all four manifestations), it is necessary to determine the corresponding regression dependencies. The independent variable (x) is the index of digitization of economy (Digital Competitiveness), calculated by IMD World Competitiveness Center. Dependent variables are as follows:

- index of global competitiveness calculated within the World Economic Forum (y_1);
- innovation index of the economy (Global innovation index), calculated by WIPO (y_2);
- the unemployment level in the economy, calculated by the World Bank (y_3);
- cybersecurity index (Global Cyber Security Index), calculated by the International Telecommunication Union (y_4).

The models that reflect dependence $y_{1-4}(x)$ allow determining various consequences of economy's digitization. The model $y_1(x)$ is to show the change in the level of the economy's global competitiveness depending on its digitization. The model $y_2(x)$ aims at reflecting the influence of digitization on the level and rate of economy's innovative development. The model $y_3(x)$ is to show social consequences of economy's digitization in the aspect of change of the unemployment level. The model $y_4(x)$ shows the influence of economy's digitization on its cybersecurity—i.e., the level of its vulnerability to the influence of anthropogenic factors (e.g., telecommunication infrastructure, continuity of work of technical devices, and defense from attacks of cyber criminals).

Initial statistical data (2013-2019) for analysis are shown in Table 1.

Table 1. Indicators of digitization of Russia's economy, 2013-2019

Indicator		2013	2014	2015	2016	2017	2018	2019
Index of digitization of economy, points 1-100	x	46	42	41	40	42	40	42
Index of global competitiveness, points 1-7	y_1	4.2	4.2	4.4	4.4	4.5	4.6	6.67 (66.7)
Innovation index, points 1-100	y_2	37.2	39.14	39.32	38.5	38.76	37.9	37.62
Unemployment, % of work force	y_3	5.46	5.16	5.57	5.54	5.17	5.43	5.5

Cyber security index, points 0.01-1.00	y ₄	0.548	0.500	0.488	0.676	0.788	0.750	-
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Sources: compiled by the authors based on IMD World Competitiveness Center (2020), World Economic Forum (2020), WIPO (2020), International Telecommunication Union (2020), and World Bank (2020).

The research methodology is based on the method of regression analysis, which is used to determine the regression dependences of innovation development indicators (y₁-y₄) on the level of digitization (x) of the Russian economy in 2013-2019 (2019 data is valid for 2020, since 2020 reports will be published in late 2020 or early 2021).

4. Results of modelling of innovation development of the Russian economy on the base of AI

4.1. Causal connections of the development of AI in Russia

Based on Table 1, we calculated characteristics of regression dependence of the values of indicators of consequences of digitization of economy on its level (Figure 1).

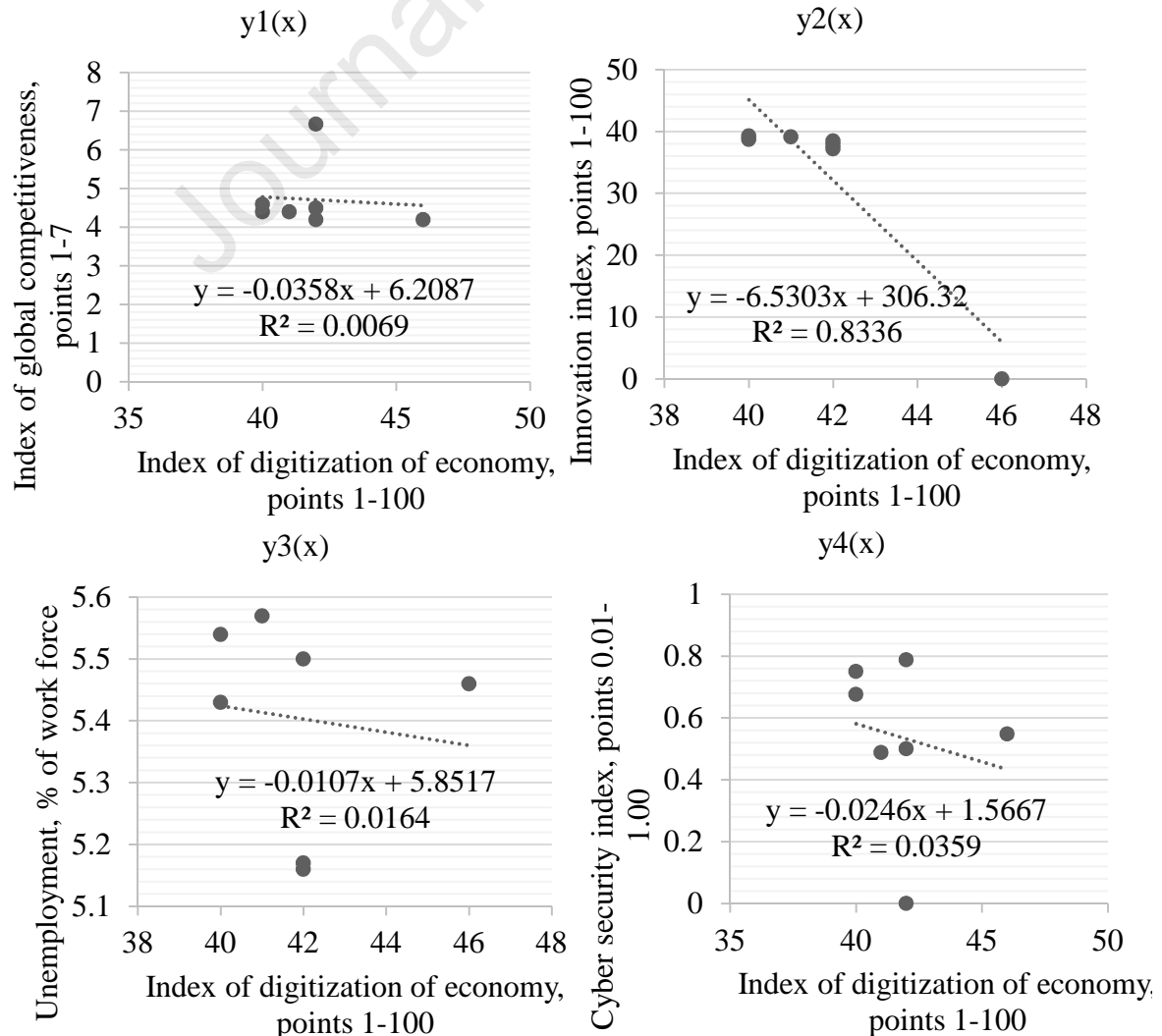


Figure 1. Innovation development vs. digitization of Russia's economy, 2013-2019.

Source: Authors' calculations.

As is seen from Figure 1, the value of the global competitiveness index is by 0.69% (R^2) explained by the value of the index of digitization of Russia's economy in 2013-2019. An increase of the index of digitization by 1 point would reduce the value of the index of global competitiveness for Russia by 0.0358 points. The value of innovation index is by 83.36% (R^2) explained by the value of the index of digitization of Russia's economy in 2013-2019. Increase of the value of the index of digitization by 1 point in Russia in the 2013-2019 lead to reduction of the value of innovation index of the economy by 6.5303 points.

Unemployment level is by 1.64% (R^2) explained by the value of the index of digitization of Russia's economy in 2013-2019. An increase of the value of the index of digitization by 1 point in Russia in 2013-2019 leads to reduction in the unemployment level in the economy by 0.0107%. The value of cybersecurity index of competitiveness is by 3.59% (R^2) explained by the value of the index of digitization of Russia's economy in 2013-2019. Increase of the value of the index of digitization by 1 point in Russia in 2013-2019 leads to reduction of the value of cybersecurity index of the economy by 0.0246 points.

On the basis of the determined dependencies, it is to be expected that AI, when implemented in the real sector of economy, could have contradictory influence on economy, stimulating growth and reduction of global competitiveness and innovative development of this sector; also, it will lead to reduction of unemployment level and decrease of cyber security of this sector due to its vulnerability as to cyberattacks. This emphasizes perspectives and expedience of application of AI in the real sector of Russia's economy and, at the same time, shows the necessity for managing this process in the interests of overcoming its possible negative consequences.

4.2. Scenarios of development of AI in Russia until 2024.

Let us set a scale for measuring the level of digitization of Russia's economy from the development of AI. At present (2020), the level of digitization of the Russian economy is given 40 points (out of 100). The maximum value of this indicator for recent six years was seen in 2013—46 points. At the present level of the Russian economy's digitization, AI is at the stage of development, which will need added digitization.

The first (zero) value—the lower threshold of the scale—at which AI is created but not implemented, is 50 points. Digitization and AI will be more disseminated in the economy. The upper threshold values of intervals of the scale are the following indices of digitization of Russia's economy:

- 70 points: the minimum level of implementation of AI. In case of the economy, this envisages usage of AI in specific (rate) production operations;
- 85 points: high level of implementation of AI; this means the transfer of most production operations into control of AI;
- 100 points: maximum level of implementation of AI; this is related to the establishment of full control of AI over production operations.

Putting these threshold values in the formulas y_1 - y_4 , we get an idea of the most probable consequences of dissemination of AI in the economy. With the value of the index of digitization of 70 points, the following consequences for the economy are (as compared to the 2020 level):

- index of global competitiveness (y_1) achieves maximum value (7 points), increasing by 1.52 times;
- innovation index of the economy (y_2) grows by 1.15 times, constituting 43.76 points;
- the unemployment level in the economy (y_3) grows by 1.62 times, reaching 8.79% of the workforce;
- cybersecurity index (y_4) decreases by 6.52 times to 0.115 points.

This means starting a new wave of its intensive development with preservation of the unemployment level and cybersecurity at the acceptable level. Therefore, the effectiveness of the distribution of AI in the economy exceeds 1—i.e., advantages are higher than expenditures (negative consequences).

With the value of the index of digitization of 85 points, the following consequences for the economy are (as compared to the 2020 level):

- index of global competitiveness (y_1) has already achieved its largest threshold, but the level of competitiveness grows by 5.76 times;
- innovation index of the economy (y_2) grows by 1.23 times, constituting 46.69 points;
- the unemployment level in the economy (y_3) grows by 1.93 times, reaching 10.48% of the workforce;

- cybersecurity index (y_4) is brought down to zero.

A transition to a new level of development, which ensures the growth of its competitiveness. However, expenditures are also high and are related to the critical vulnerability, controlled by the AI, against cyber-attacks and systemic failures in the work of AI. The effectiveness of the distribution of AI in the economy is below 1 (but above 0), that is, expenditures (negative consequences) are equal to or exceed advantages.

With the value of the index of digitization of 100 points, the following consequences for the economy are (as compared to the 2020 level):

- index of global competitiveness (y_1) reaches the peak level;
- innovation index of the economy (y_2) grows by 1.31 times and constitutes 49.62 points;
- the unemployment level in the economy (y_3) grows by 2.24 times, reaching 12.17% of the workforce;
- cybersecurity index (y_4) has reached its minimum level but continues to reduce.

A revolutionary leap in its development and achievement of the peak of competitiveness and innovativeness. However, apart from a crisis of cybersecurity, this is accompanied by social crisis due to mass unemployment. Therefore, the effectiveness of the implementation of AI becomes lower than 0—i.e., expenditures (negative consequences) well exceed advantages.

The scale is shown in Figure 2.

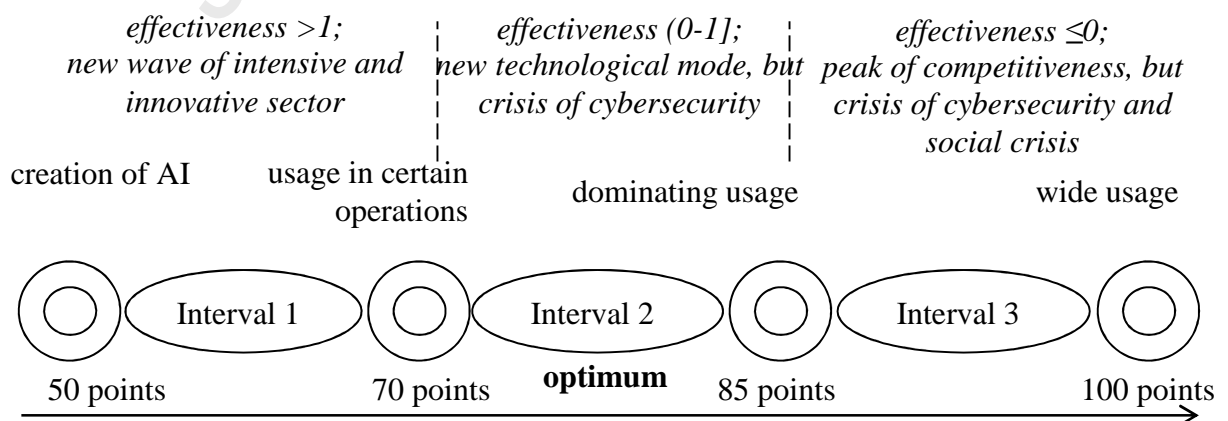


Figure 2. Scale for measuring the level of digitization of Russia's economy from the development of AI.

Source: compiled by the authors.

Comparative analysis of consequences with various levels of its digitization and distribution of AI according to Figure 2 showed that the most preferable is interval 2, which envisages usage of AI in (rare) production operations but does not allow its dominating usage. For this, the level of digitization of economy should be above 70 points but less than 85 points.

This would allow gaining advantages from the implementation of AI in the economy, related to the growth of global competitiveness, the activation of an intense innovative development, and avoid negative consequences—a crisis of cyber security and social crisis—i.e., preserving the sustainability of socio-economic system in the long-term.

4.3. The strategy of risk management in the development of AI in Russia

Development of the AI in Russia opens perspectives for the growth of its effectiveness, related to the following advantages:

- improvement of technical characteristics of industrial products: due to full-scale automatization under control of AI, it would be possible to manufacture more complex products with the help of high-precision production operations;
- integration of production processes into the industry: instead of a lot of separate managers for each production process and project, management will be conducted by AI, which will ensure the systemic integrity of the production process, due to which speed of production and quality of industrial will grow;
- improvement of the technical maintenance of industrial equipment: AI monitoring (based on the Internet of Things) of industrial equipment will ensure the extension of lifespan and continuity of work for the stable industrial process;
- “scale effect” in the management of industrial production: AI will allow replacing intellectual workers in the industry (managers), which will ensure the economy of managerial expenditures.

These advantages are the basis of growth of competitiveness and emphasize the application of AI. However, this process is related to the following risks:

- risk of excessive digitization and increase of negative consequences: this risk is related to going beyond the set limits of the interval of digitization of Russia’s economy (70-85 points). As a result, the negative consequence will hit a critical level;

- risk of AI crisis: risk of implementation of unprepared (underdeveloped) AI, errors, and failures (technical and software failures) in which work may paralyze the production process;
- risk of social crisis: risk of mass public opposition to the implementation of AI in the economy from workers, who are dissatisfied by labor force the wave of dismissals due to automatization of production, and from consumers, who are not susceptible to innovations in Russia;
- risk of a crisis of cybersecurity: this risk is related to the insufficient level of development of infrastructural works of AI in the economy and impossibility of supporting the security of this sector at the high level (primarily, due to cyber-attacks).

The developed complex of measures of risk management in the development of AI in Russia includes the following:

- preliminary preparation of interested parties: social advertising of application of AI in the economy, the conduct of consultations with workers of industrial companies about future dismissals, choice of new jobs, and stimulation of additional training – these measures are implemented jointly by industrial companies and the state;
- preliminary preparation of infrastructures: development of high-speed Internet and development of AI—these measures are implemented jointly by industrial companies and the state;
- gradual digital modernization: the state conducts refusal from quick modernization and gradual (for 5-10 years) implementation of AI in the economy—control over the process of modernization;
- limitation of the level of digitization: the state conducts prevention of going beyond the set limits of the interval of digitization of Russia's economy (70-85 points) and prevention of transition of most production operations to AI control - control over the process of modernization.

Implementation of the offered strategy will allow bringing down to the minimum the probability of certain risks and ensuring the high effectiveness of digital modernization of Russia.

5. Discussion

The research contributes to the development of the theory of innovations, extending its boundaries and specifying the essence of modern innovative development of the economy through the justification of the reliance on the dissemination of AI. Unlike existing research papers and publications, this paper emphasizes not evolutionary innovations (marketing, organizational) that provide a moderate acceleration of economic growth, but disruptive, revolutionary innovations (corresponding to the Fourth Industrial Revolution, industry 4.0). As a result, the research presents a fresh approach to the prospects of accelerating the innovative development of the economy, where AI should serve as the growth vector, as proved by the example of Russia.

6. Conclusions

Both advantages for the development of the economy from the implementation of AI and risks of digital modernization of the Russian economy (risk of excessive digitization and increase of negative consequences, the risk of a crisis of AI, the risk of social crisis, and risk of a crisis of cybersecurity) are determined. Analysis of causal connections of implementation of AI in Russia allows us to determine the optimal level of digitization (70-75 points), at which specific production operations limit the use of AI, the fast growth of competitiveness and innovative development of the economy might be achieved. The unemployment level would grow by 1.62 times (as compared to 2020) and stay at the acceptable level, and the level of cybersecurity decrease by 6.52 times (as compared to 2020). The effectiveness of digital modernization by AI would be above 1. These findings would recommend using the developed strategy of risk management in the development of AI in Russia. Contrary to the existing literature, in which the advantages of unlimited perspectives of its application are stated, we have shown that each economic system must select an optimal interval of AI. Our findings set the limits of the implementation of AI in Russia and the interval that may reduce the effectiveness of this process.

The article contributes to the development of the theory of innovations, specifying the logic of the optimization of innovative development. The significance of the research consists in the application of the offered method for determining the optimal intervals of proper usage of AI in Russia. The key conclusion that can be drawn from the research is the justification of the need to promote the modernization of the Russian economy on the basis of AI with a view to accelerating its innovative development until 2024. The consequences of the research are

involved with the improvement of practices of public regulation of the innovative development of the Russian economy by promoting the dissemination of AI according to recommendations proposed by the authors.

This research is limited by its focus on Russia. Although its experience may be useful for many other developed (OECD) and developing (BRICS, EEA, CIS) countries, several international studies should be conducted using the example of many countries of the world to identify global prospects for the innovative economic development on the basis of AI. It is recommended that further research in this field be concerned with it.

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1. This article explores different scenarios of implementing AI in Russia. This article contributes to the theory of innovation, thereby specifying the logic of the optimization of innovative development and the optimal scale in a strategy of risk management.
2. The significance of the research consists in the application of the offered method for determining the optimal intervals of AI usage in Russia.
3. Implementation of the offered strategy will allow bringing down to the minimum the probability of certain risks and ensuring the high effectiveness of digital modernization of Russia.
4. Development of the AI in Russia opens perspectives for the growth of its effectiveness.