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Conditions and Results of Innovative Development in Latin America and Russia: A Comparative Analysis

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ABSTRACT

Relevance. The problems of innovative development and effective innovation management have long been a priority in the world economy and, most likely, their relevance will be in the mainstream for many years to come. The paper analyses the provision and performance of innovation processes in nine countries of Latin America and Russia in **order** to identify the most successful economies in terms of approaches and effects of innovation activity in different evaluation planes. The specifics of structural efficiency of innovation activity components in crisis and post-crisis periods have been studied. **Research methods** — comparative analysis of the structure of the global innovation index (GII) in the target countries in 2020 and 2023, multiple regression analysis of the impact of resources and innovation results on the level of the global innovation index, t-statistics to compare the innovation dynamics of the target countries in the period from 2020 to 2023. **Scientific novelty** — on the basis of statistical approach the specifics of innovative development of Latin American countries and Russia and regularities of achieving different levels of the global innovation index in the crisis and post-crisis periods are revealed. **The results of the study** show that the leaders in terms of GII level among Latin American countries are Brazil, Chile, Uruguay, Colombia and Argentina, and the most important for the formation of GII are the components of innovation results — the development of technology and knowledge economy, as well as the results of creative activity. Ecuador and Peru are the countries with the most detached innovation development trajectory. In the year of the covid crisis the components of institutions and market development were particularly developed, in the post-covid year — the level of business development, as well as human capital and research. Finally, the dynamics of GII in Russia is closest to Brazil in most components. The results obtained are of **practical value** as a reference point in the development and adoption of economic and political decisions on the reallocation and concentration of resources for the development of the most effective components of GII.

Keywords: innovation; innovative development; innovation management; global innovation index; innovation resources; innovation results; Latin America; crisis; comparative analysis; regression analysis

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INTRODUCTION

Innovation in the management of both the state and corporations is a necessary condition for socio-economic development. For more than 20 years, scientific literature has referred to it as a fundamental driver of growth [1, 2]. However, this concept is so broad and ambiguous that it is often perceived as a call to action rather than a strict requirement for improving efficiency. But what is the structure of innovation? How significant are its components, and are they equally important?

We will address these questions using the example of Latin American countries and Russia.

Why did we choose Latin America?

Firstly, the countries in this region exhibit significant differences in their levels of innovation development.

Secondly, they are geographically close to one another, allowing us to disregard physical factors that could significantly impact the conditions and outcomes of innovation activities.

Thirdly, these countries share certain similarities with Russia.

Fourth, there is a noticeable gap in scientific literature concerning developing countries.

The wealth of natural resources and cultural heritage is considered the primary driver of innovation in Latin American and Caribbean countries [3]. In particular, research and development efforts are often focused on the mining industry [4], transportation logistics, and related infrastructure [5]. At the same time, there are also advancements in renewable energy and environmental sustainability.[1] A key reason for the lag in other sectors is the extractive nature of institutions, which prevents economies from moving beyond traditional business models [6, 7]. One study also highlights high levels of social inequality and poverty as major barriers to innovation [8]. As a result, researchers recommend measuring innovation indicators at the country level and conducting longitudinal analyses of the most successful nations in terms of innovation and sustainable development.

Some studies attempt to compare innovation characteristics across different countries, including those in Latin America. For example, when examining the Asia-Pacific and Latin American regions, scholars have noted that despite similar income levels, their growth strategies differ: the former prioritizes export-oriented development, while the latter relies on import-substitution technologies and domestic markets. However, in both cases, innovation remains a crucial factor for economic growth and macroeconomic stability [9]. Patent activity is often cited as the primary outcome of innovation, though its direct impact on a country's technological and economic efficiency remains ambiguous.

Other researchers have found that in six Latin American countries, the conditions for investing in innovation are far more heterogeneous than in member states of the Organization for Economic Co-operation and Development (OECD) [10]. Consequently, accurately predicting the conditions under which investment in innovation becomes reliable remains a significant challenge.

When considering the prospects for cooperation between the European Union and Latin America, one of the stated goals is to strengthen best practices and enhance the EU's attractiveness in research and innovation, as well as its financial and industrial competitiveness [11]. At the same time, the authors identify addressing environmental issues as a primary objective for developing countries. They also highlight the significant disparities in R&D funding across Latin American and Caribbean nations and propose joint programs to support scientific research and academic mobility as a means of leveling these differences.

It should be acknowledged that innovation development is not a top priority for Latin American countries — the main drivers of social and economic development in the region are identified as institutional factors [12]. Additionally,

[1] URL: https://www.scidev.net/america-latina/news/chile-comienza-a-revertir-baja-inversion-en-ciencia-y-tecnologia/

the region demonstrates relatively weak patent activity [13].

Notably, there is a lack of comparative studies examining innovation dynamics in Latin American countries and Russia. In particular, D.S. Bezhko points out that these economies are only beginning to enter the post-industrial phase and therefore require unique development trajectories. The study identifies similar innovation development tools in both regions, such as technology parks. However, in Latin America, their creation is primarily driven by private investors, whereas in Russia, it is predominantly initiated by the state [14].

DATA AND METHODS

The primary information base for this study consists of publicly available data on the Global Innovation Index (GII) for 2020 and 2023, with the main source being reports from the World Intellectual Property Organization[2] (WIPO). The research focuses on comparing differences between the crisis year (2020) and the post-crisis year (2023).

The Global Innovation Index has been published since 2007 by WIPO in collaboration with the Network of Academic Partners. It includes 80 indicators grouped into seven categories, covering 132 countries.

This study utilizes quantitative GII values for Russia and Latin American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay), along with data on innovation resources and outcomes, as well as detailed breakdowns of these metrics.

The key components of the GII are calculated as the average of two sub-indices, each of which is based on multiple aggregated components (aggregates):

- innovation resources, [aggregates: institutions (Ins), human capital and research (HCR), infrastructure (Infr), market sophistication (MS), business sophistication (BS)];
- innovation output, [aggregates: knowledge and technology outputs (KTO), creative outputs (CO)].

To determine the significance of GII aggregates in shaping the final indicator, a multiple regression analysis was conducted using a model of the following type:

$$y = b_0 + b_1x_1 + b_2x_2 + \ldots + b_ix_i + \varepsilon, \quad (1)$$

where y is the dependent (explained) variable, the Global Innovation Index; x_1, x_2...x_i are the independent variables representing the GII aggregates; b_0 is the intercept; b_1, b_2...b_i are the regression coefficients; I is the number of independent variables; ε is the random error (deviation).

This method allows us to determine the degree of influence that each selected predictor and their combination has on the formation of the dependent variable. Its advantage over alternative approaches lies in the relatively simple assessment of model reliability through tests for multicollinearity and the variance inflation factor (VIF). Additionally, the adjusted coefficient of determination helps establish how much the dependent variable depends on the set of selected regressors.

To compare countries across different years in terms of GII aggregate dynamics, t-statistics were calculated for independent variables.[3] Differences between Latin American countries were assessed separately, followed by a comparison between Russia and each of them. This approach provided insights into which countries exhibit minimal differences and which follow unique innovation trajectories.

[2] URL: https://www.wipo.int/ru/web/global-innovation-index

[3] The calculations were made based on the sources: URL: https://www.wipo.int/documents/d/global-innovation-index/docs-en-2020-wipo_pub_gii_2020.pdf; https://www.wipo.int/documents/d/global-innovation-index/docs-en-2021-wipo_pub_gii_2021.pdf; https://www.wipo.int/documents/d/global-innovation-index/docs-en-wipo-pub-2000–2022-en-main-report-global-innovation-index-2022–15th-edition.pdf; https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000–2023-section5-en-gii-2023-economy-profiles-global-innovation-index-2023–16th-edition.pdf

For a clear representation of GII aggregates and related indicators, graphical and comparative analysis methods were employed. These methods have proven effective in previous comparative tests of innovation dynamics in individual countries [15].

The key questions of the analysis are as follows:

1. Which countries are the most successful in terms of innovation and innovation resource management?

2. Which countries deviate the most in innovation development dynamics from the top-performing ones?

3. Which innovation factors should be prioritized to achieve the best results?

RESULTS AND DISCUSSION

The ability of the multiple regression econometric model to explain the dependence of the Global Innovation Index (GII) on its individual aggregates is logical since the index itself is calculated based on these components. However, the presented models (2) and (3) allow us to assess the degree of impact that each individual aggregate had on GII in 2020 and 2023.

2020:

$$GII_{2020} = -0,06 + 0,098 \times Ins + 0,1 \times HCR + \\ + 0,1 \times Infr + 0,1 \times MS + 0,1 \times BS + 0,25 \times \\ \times KTO + 0,26 \times CO; \quad (2)$$

2023:

$$GII_{2023} = -0,29 + 0,098 \times Ins + 0,1 \times HCR + 0,11 \times \\ \times Infr + 0,102 \times MS + 0,093 \times BS + 0,25 \times KTO + \\ + 0,252 \times CO, \quad (3)$$

where: *GII* is Global Innovation Index for 2020 and 2023, respectively; *Ins* is–Institutions aggregate; *HCR* is Human Capital and Research aggregate; *Infr* is Infrastructure aggregate; *MS* is Market Sophistication aggregate; *BS* is Business Sophistication aggregate; *KTO* is Knowledge and Technology Outputs aggregate; *CO* is Creative Outputs aggregate.

Validation tests confirm the reliability of the models: for model (2): F-statistic (Fisher's criterion) = 115.494.4, p-value (confidence level) = 0.0023, R^2 (coefficient of determination) = 0.99999876, R^2_{corr} (adjusted coefficient of determination) = 0.9999901, for model (3): F-statistic = 95,955.09, p-value = 0.0025, R^2 = 0.99999851, R^2_{corr} = 0.99998809.

These results are further confirmed by multicollinearity tests and variance inflation factor (VIF) analysis.

Let's pay attention to the coefficients linked to different regressors. Thus, the regression coefficients show that the most significant impact on the final GII score comes from the Creative Outputs (CO) aggregate, with coefficients of 0.26 in 2020 and 0.252 in 2023, as well as Knowledge and Technology Outputs (KTO), which remains at 0.25 for both years. These findings align with the nature of these aggregates, which reflect innovation performance and naturally have the highest coefficients. The slightly higher CO coefficient in 2020 is likely due to the increased demand for creative industry products during the pandemic-induced isolation [16, 17].

The impact of innovation resources on the overall GII remained relatively equal across both years, with minor variability in 2023, possibly due to the broader opportunities for innovation development during this period.

Graphical relationships between the aggregate values of innovation results and GII in Latin American countries and Russia are presented in *Fig. 1*.

According to observations:

1. Chile had the highest GII in 2020, while Brazil led in 2023. Uruguay, Colombia, and Argentina followed closely behind.

2. Innovation performance improved in almost all countries by 2023.

3. The most significant growth in innovation outputs was observed in Brazil, Chile, and Argentina.

4. In 2020, KTO exceeded CO only in Brazil. By 2023, this trend extended to Colombia

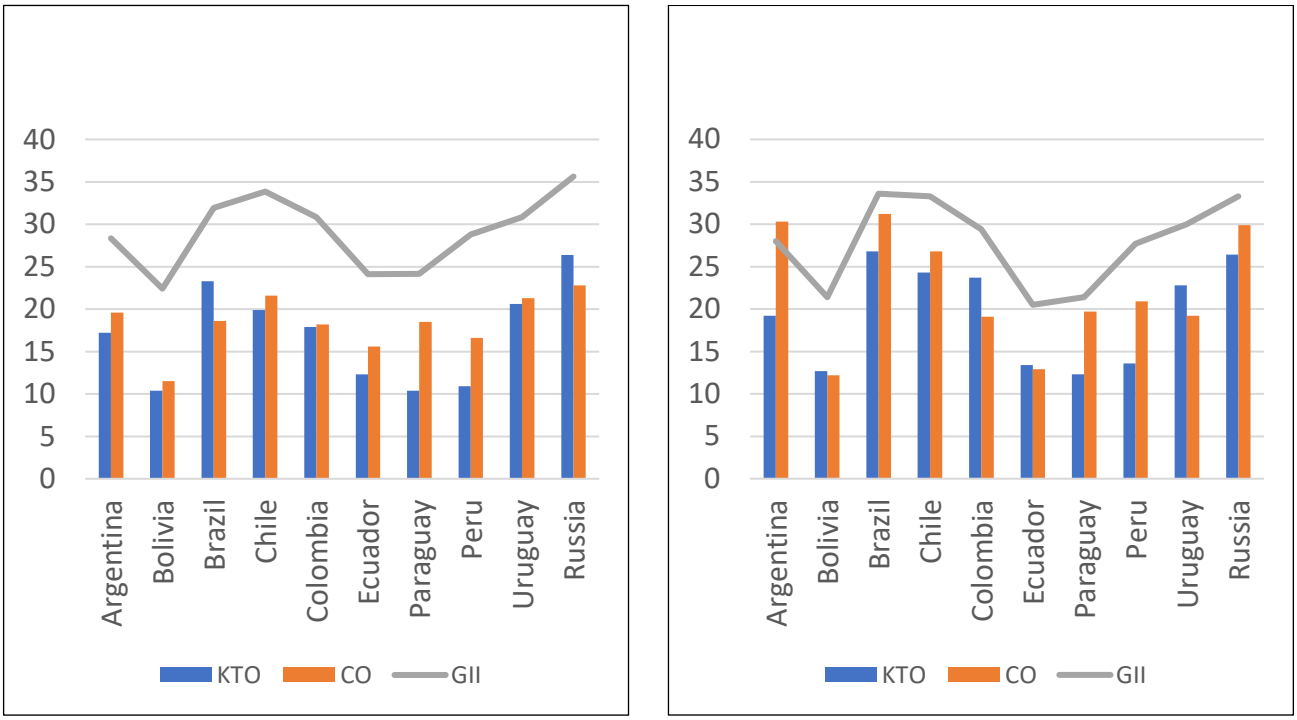

Fig. 1. **Ratio of GII levels in Latin American countries and Russia to KTO and CO aggregates in 2020 (left) and 2023 (right), in points**

KTO – knowledge and technology outputs, CO – creative outputs, GII – Global Innovation Index.

Source: compiled by the author on the basis of data: URL: https://www.wipo.int/documents/d/global-innovation-index/docs-en-2020-wipo_pub_gii_2020.pdf; https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2023-section5-en-gii-2023-economy-profiles-global-innovation-index-2023-16th-edition.pdf

and Uruguay, indicating a post-crisis push for knowledge-based economies and technological innovation.

The relationship between the innovation performance components of the GII in Russia for both years is most similar to the situation in Brazil. It should be noted, however, that the absolute values of the innovation performance components and the overall index in 2020 in Russia were higher than in any of the Latin American countries considered, while in 2023, Brazil led. Thus, the opinion about the global similarity between Russia and the countries in this region in cultural and mental aspects is confirmed [18].

According to the Latin American country sample, pairwise comparisons of the data series reflecting the dynamics of aggregated innovation performance results between 2020 and 2023, along with the corresponding calculation of *t*-statistics for independent variables, showed the following:

1. The most noticeable individual dynamics of innovation results (both *KTO* and *CO*) were observed in Ecuador, with differences from Argentina, Brazil, Chile, and Colombia. Specifically, for *KTO*, differences were found with Uruguay, and for *CO*, with Paraguay and Peru. This is due to the slight overall growth in *KTO* and the decline in *CO* in Ecuador compared to the aforementioned countries. Moreover, the most negative dynamics in the *KTO* aggregate were observed in the "creative knowledge" and "knowledge dissemination" groups, with only a slight growth in "knowledge impact." In turn, a significant decline in the CO aggregate occurred in the "intangible assets" and "creative goods

and services" groups, with a noticeable increase in "online creativity."

2. A high degree of individuality was identified in Peru: significant differences were found with Chile in both *KTO* and *CO*; separately for *KTO* — with Argentina, Brazil, Colombia, and Uruguay; for *CO* — with Ecuador. A detailed analysis showed a more favorable situation in Peru compared to Ecuador: positive dynamics were observed in all KTO indicator groups, with the highest growth in the "knowledge impact" group; the overall CO aggregate dynamics were also positive, with significant growth in the "intangible assets" and "online creativity" groups, alongside a sharp decline in "creative goods and services."

3. Countries where no differences were found in any innovation performance component: Argentina and Colombia, Colombia and Uruguay, Brazil and Chile, Chile and Uruguay, Paraguay and Peru. This is explained by the similar dynamics of innovation performance indicators in the named pairs. Sometimes, no differences between the two countries are observed, as in the case of the uniform growth of KTO indicators in Argentina and Colombia, Colombia and Uruguay, or due to alternating periods of growth and decline, as in Brazil and Chile, Paraguay and Peru.

The use of *t*-statistics to compare Latin American countries and Russia revealed the following.

1. In the dynamics of innovation results, both *KTO* and *CO*, no significant differences were found between Brazil and Russia. In 2023, Russia remained at the same level, while Brazil experienced a slight increase, which was statistically insignificant for conclusions about differences between the countries. However, in the structure of both countries' aggregates, there were both increases (in the "knowledge impact" group, a positive dynamic of the "high-tech production" indicator was observed) and setbacks ("knowledge dissemination"). Furthermore, a significant growth in the overall *CO* aggregate value was noted both in the Russian Federation (from 22.8 in 2020 to 29.9 in 2023) and in Brazil (from 18.6 to 31.2, respectively), primarily due to the positive dynamics in the "intangible assets" and "online creativity" groups.

2. For other countries in the region, differences in the dynamics of *KTO* were observed with Russia.

3. For the *CO* aggregate, no differences were found between Argentina and Russia, Chile and Russia, Paraguay and Russia, and Uruguay and Russia. This confirms their significant similarity in the areas of creative activity and aligns with previous conclusions about the creative economy in Latin America as a new vector for the development of foreign trade relations [19].

Next, we will analyze the relationships between the aggregate values of innovation resources and GII in the Latin American countries and Russia (*Fig. 2*).

Analysis of the presented diagrams allows for the following conclusions:

1. The levels of innovation resources across countries in 2020 and 2023 differ.

2. There was a significant (sometimes more than twice) decrease in the levels of the *Ins* and *MS* components in all countries, with a few exceptions. The most negative dynamics were observed in Argentina (a decrease of 43.1% for *Ins* and 27.2% for *MS*), Brazil (a decrease of 34.2% for *Ins* and 10.8% for *MS*), Paraguay (a decrease of 33.7% for *Ins* and 25.3% for *MS*), Colombia (a decrease of 28.3% for *Ins* and 34.8% for *MS*), etc.

3. Variable dynamics were observed for the *HCR* and *Infr* components, with the most significant decline in *HCR* seen in Paraguay (46%) and Argentina (16.4%).

4. The most positive dynamics were observed in the *BS* component, especially in Uruguay (32.1%) and Colombia (25.2%).

The analysis of *t*-statistics for independent variables comparing the dynamics of innovation resources in Latin American countries showed the following:

1. Significant differences in all five innovation resource aggregates were confirmed between Uruguay and Brazil, as well as between Uruguay and Peru. It should be noted that the differences

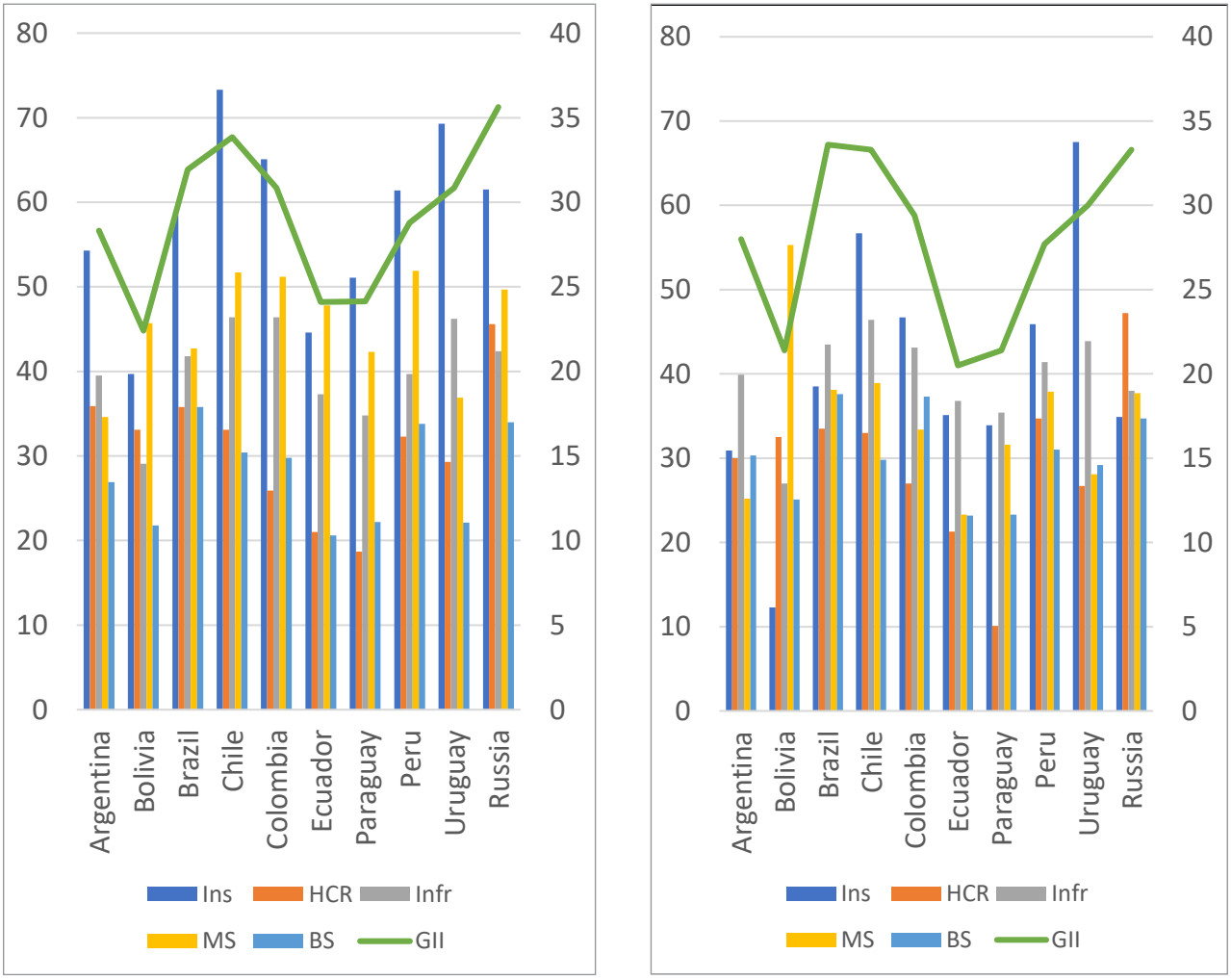

Fig. 2. **Ratio of Latin American and Russian GII levels with Ins, HCR, Infr, MS, BS aggregates in 2020 (left) and 2023 (right), in points**

Ins — institutions, HCR — human capital and research, Infr — infrastructure, MS — market sophistication, BS — business sophistication, GII — Global Innovation Index.

Source: compiled by the author on the basis of data: URL: https://www.wipo.int/documents/d/global-innovation-index/docs-en-2020-wipo_pub_gii_2020.pdf; https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000–2023-section5-en-gii-2023-economy-profiles-global-innovation-index-2023–16th-edition.pdf

in favor of Uruguay are explained by a substantial decline in a number of GII aggregates in Brazil and Peru. These findings are confirmed by the economic monitoring results of Brazil and Uruguay conducted by the Economic Development Advisory Council of the Catholic University of Uruguay.[4]

2. Differences were found in four aggregates (except *MS*) between Ecuador and Chile, Ecuador and Colombia, and Paraguay and Chile. The reasons lie in statistical calculations: either due to varying degrees of decline, often depending on the base values of 2020 (as in the case of Ecuador and Chile, Paraguay and Chile), or due to the different nature of dynamics [uniform dynamics does not coincide with volatile indicators (Ecuador and Colombia)].

3. The differences are minimal (no more than two aggregates) between Argentina — on the one hand, and Brazil (*MS* and *BS*), Colombia (*HCR* and *Infr*), Ecuador (*HCR* and *BS*), Paraguay (*HCR* and

[4] URL: https://sudamerica.ru/uruguay/kak-ehkonomicheskaya-aktivnost-urugvaya-sootnositsya-s-argentinoj-i-braziliej

BS), Peru (*MS* and *BS*), Uruguay (*Ins* and *BS*) — on the other hand.

In turn, the study of *t*-statistics for Latin American countries and Russia in order to compare them showed the following:

1. For the *Ins* aggregate, no significant differences were found between Russia and all countries in the region. Here the decline in the values of this aggregate in all the studied countries is worth noting: a significant decrease was observed in the groups "political environment" and (especially) "business environment" in Argentina, Brazil, Colombia, Chile, Peru, Paraguay, and Russia. A less noticeable decline was observed in the "legal framework" group.

2. For the *HCR* aggregate, in contrast, differences were found between Russia and all the countries in the region. A slight increase in the total value of the aggregate was observed for Russia due to growth in the values of the "general education" and "R&D" groups, and a slight decrease in "higher education."

3. For the *Infr* aggregate, differences were found between Russia — on the one hand, and Chile, Colombia, and Uruguay — on the other. The negative dynamics of the total values of this aggregate in Russia were associated with a slight decrease in the values of the "information and communication technologies," "general infrastructure," and a more significant decline in "environmental sustainability" groups. In the comparable Latin American countries, the dynamics were not so unambiguous.

4. For the MS aggregate, differences were found between Russia — on the one hand, and Argentina and Uruguay — on the other. The latter demonstrated negative dynamics in all three structural groups of indicators: "credit," "investments," and "trade, competition, and market size"; in Russia, there was growth in the last group, although a decline was observed in the first two.

5. For the *BS* aggregate, no differences were found between Russia and Colombia, which likely reflects the predominantly positive dynamics of indicator values for this aggregate across all three groups: "knowledge workers," "innovation linkages," and "knowledge absorption."

In previous works, the author proposed approaches to building innovation systems and forming a knowledge economy [20, 21]. Now, based on the analysis, we will formulate generalized recommendations based on statistically confirmed similarities and differences between countries in the field of innovation dynamics, which may serve as directions for further research.

1. The government of Ecuador should conduct a comprehensive analysis of the specifics of managing innovation processes in Brazil and Chile (primarily), Argentina and Colombia, as well as thoroughly study the scientific and technological performance of Uruguay.

2. The government of Peru should comprehensively study the specifics of managing innovation processes in Chile and conduct a detailed analysis of the scientific and technological performance of Brazil, Argentina, Colombia, and Uruguay.

3. The governments of Brazil, Chile, Argentina, Uruguay, and Colombia should collaborate on the development and implementation of innovation policies, which would activate the introduction of innovations into the economies of these countries.

4. The government of Russia should initiate and support domestic research on the dynamics of innovation activity and performance in Brazil, as well as, in certain areas, Argentina, Chile, Paraguay, and Uruguay, due to the similarities in the development of innovation activities and results. The tasks of such work will be, on one hand, to identify the factors that accelerate or, conversely, hinder innovation development, and on the other hand, to determine the conditions and prerequisites for increasing innovation activity.

CONCLUSION

There are studies that identify a consistent sequence where first, the socio-economic develop-

ment of a country creates the conditions for the formation of innovations, and then these innovations significantly influence the development of society [22, 23]. The purpose of the comparative analysis between countries is to identify leading, stagnating, and lagging states, as well as to determine the causes of the observed dynamics.

Comparing countries with similar conditions of existence and development allows us to focus on a specific research subject and, accordingly, more accurately identify the causes of a given situation, develop scenarios, and mechanisms for its positive changes.

The main conclusions of this work are as follows:

1. Developing countries (including Latin American states), unlike developed ones (mostly European countries and the USA), are rarely subject to analysis of innovation activity and dynamics. At the same time, the innovativeness of each country in the region is different: both in general — based on the set of indicators within the *GII* — and across individual groups of innovation aggregates.

2. The leaders in terms of *GII* among Latin American countries are Brazil, Chile, Uruguay, Colombia, and Argentina.

3. The most important components for the formation of the *GII* are the results of innovation: the development of technology and the knowledge economy, and creative activities.

4. The most distinct innovation development trajectory is observed in Ecuador and Peru.

5. In 2020, particular attention was given to the components of institutions and market development, while in 2023, the focus shifted to business, as well as human capital and research.

6. The Russian Federation, in terms of economic development and innovation activity, is quite similar to the countries of the studied region. The dynamics of *GII* in Russia for most components is most similar to Brazil. At the same time, in terms of indicators that characterize the use of knowledge and technology, Russia differs from the other countries, while for those defining creative outcomes, it is similar to four other countries.

The results of the work have some limitations, related to certain calculation errors of the global innovation index and the occasional lack of data, which sometimes necessitates trend-based assessments of specific indicators across years. Nevertheless, the development of this topic is promising due to its high expected impact in both global and national contexts.

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Development of Advanced Space Technologies and Systems as the Basis of Russia's Technological Sovereignty

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ABSTRACT

The relevance of this study is driven by the critical importance of developing high-tech and knowledge-intensive industries for the Russian economy. The article argues that scientific research and development in the space industry serve as both an indicator of Russia's scientific and technological progress and a subject of international competition. The results of space activities are in demand by a wide range of consumers. Space technologies are used as a tool for solving governmental and municipal management tasks. Services based on Earth observation sensing data from space have become an indispensable source of timely and relevant information for ensuring the operation of various sectors of the national economy. The study highlights that achieving technological sovereignty and leadership requires a comprehensive approach to the development and implementation of high-tech products and services, considering the mutually beneficial cooperation between the state and private companies. The author presents international experiences in implementing open data policies in the space sector, analyzes Russia's position in the global Earth observation market, and discusses promising space industry projects. The implementation of these projects could serve as one of the first examples of applying the private-public partnership mechanism in Russia's space sector.

Keywords: technological sovereignty; technological leadership; space industry; earth observation from space; open data; advanced space systems and services; private-public partnership

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INTRODUCTION

The development of high-tech, science-based sectors of the Russian economy is one of the priority tasks. Its solution is an important condition for the transition to an innovation economy, achieving technological sovereignty and ensuring national economic security. Technological sovereignty determines the level of the national independence achieved in the global priority high-tech science-based sectors, which ensures the implementation of national interests. According to the Concept of Technological Developments of the Russian Federation for the period up to 2030, technological sovereignty is understood as critical and cross-cutting technologies of the proper development lines and high-tech production facilities which ensure a stable capability of the State and society to achieve proper national development goals and materialise national interests.

Technological sovereignty exists in two main forms:

- research, development and implementation of critical and cross-cutting technologies (according to the established list);
- construction of high-tech products based on these technologies.[1]

Technological leadership, the achievement of which has been declared a national development goal of the Russian Federation for the period up to 2030 and in the perspective up to 2036, means technologies, technical and cost parameters of manufactured products significantly superior over foreign analogues. The transition from technological sovereignty to technological leadership within the framework of development of priority areas of the Russian Federation's economy requires the implementation of an integrated approach to the development and implementation of high-tech products and services, including effective interaction between the state and private companies in the implementation of projects in knowledge-intensive industries.

The space industry, as an established form of demonstration of the country's international prestige, is one of the priority sectors of technological development in the Russian Federation. According to the Article 2 of the Law of the Russian Federation "On the Space Activities"[2] it includes the areas shown in *Fig. 1*.

Space activities are defined as "all activities related to direct work on the exploration and use of the outer space, including the Moon and other celestial bodies".[3] The Russian Federation's rocket and space industry is represented by state and private enterprises engaged in the development and implementation of high-tech products: advanced satellites, rocket engines, space systems for earth observation from space, and so on. These enterprises reflect the level of technological development of the Russian economy and act as growth points of the high-tech sector, significantly increasing the competitiveness of our country in the global high-tech market.

The largest companies in the space industry are JSC Rocket and Space Corporation "Energia", which produces, among other things, modules for the Russian segment of the International Space Station; JSC Military-Industrial Corporation Scientific and Production Association of Machine Building, whose lineup of output products includes intercontinental ballistic missiles; JSC Rocket and Space Centre "Progress", which develops launch vehicles and satellites for earth observation from space; JSC State Space Research and Production Centre named after Khrunichev. JSC Khrunichev State Space Research and Production Centre, which have developed the new Angara family of space launch vehicles; JSC Reshetnev Information Satellite Systems, which is a leader on the Russian market in the segment of production of satellite for communication, television broadcasting, relay, navigation and geodesy; JSC Lavochkin Research and Produc-

[1] URL: https://docs.cntd.ru/document/1301657597

[2] URL: https://base.garant.ru/136323/

[3] Ibidem.

Fig. 1. **Areas of Space Activities**

Source: compiled by the author.

tion Association. JSC Lavochkin Research and Production Association, named after Lavochkin, is engaged in the production of space launch vehicles; JSC Russian Space Systems is engaged in the production of on-board equipment, equipment for space exploration, and the GLONASS satellite navigation system; JSC Research and Production Association "Energomash" named after Glushko is engaged in the production of rocket engines [1, p. 66].

In addition to state-run space companies, private companies also successfully operate in Russia. They design satellites, develop and operate space data receiving stations for low-orbit earth observation satellites, carry out operational monitoring of the Earth's surface, as well as develop and implement web GIS[4] and software.

The given analysis has revealed that different segments of the Russian space industry are developing very unevenly: "The sector specialised in Earth observation from space has a relatively modest position among other enterprises of the space industry. Nevertheless, space monitoring manufactured on the basis of Earth observation

[4] Web GIS is a type of geographic information system based on web-based data access technologies. A Geographic Information System (GIS) is a multi-functional system designed for the collection, processing, modelling and analysis of spatial data, its presentation and use for problem solving, preparation and decision-making within a company or organisation, as well as for integration into various websites and public portals.

from space data is actively used by the State and municipal administration, as well as a source of operational information for various sectors of the national economy" [2].

What is the Earth observation from space?

Earth observation from space is a process of observation of the Earth's surface by satellites equipped with various types of survey equipment. According to the Law of the Russian Federation "On Space Activities" dated 20.08.1993 No. 5663–1 (edition dated 22.07.2024 with amendments and additions dated 01.09. 2024), the Earth observation data is understood as "the primary data obtained directly by means of Earth observation equipment installed on board a satellite and transmitted or delivered to Earth from space by means of electromagnetic signals, photographic film, magnetic tape or by any other means, as well as materials obtained as a result of processing of primary data carried out to ensure the possibility of their use".[5]

The Earth observation from space industry consists of five main components, namely: satellites construction; satellites launch; operator activities for satellites control, planning and acquisition; distribution activities for the dissemination of primary information obtained from satellites; and the creation of "value-added products" based on primary information and their delivery to end users.

Figure 2 shows the scheme of Earth observation data acquisition from space, its processing and delivery to the end user.

The Earth observation results are in great demand in many sectors of the national economy, including energy, oil and gas, forestry and agriculture, cartography and land valuation, construction, etc. Government agencies use Earth observation data, for example, to prevent emergencies and control the elimination of their consequences, in the implementation of large infrastructure projects, in the inventory and accounting of regional property, in the identification of unregistered tax objects, as well as in the performance of re-surveying of landfills and in the monitoring of illegal economic activities. Space images data are in demand in the transport sector to monitor waste dumps, as well as in the process of controlling illegal economic activities. The advantages of using the earth observation method are the following: speed of data acquisition and its relevance at the moment of collection, high accuracy of processing, quality of information, economic feasibility. In addition, the level of use of such information by public authorities and business structures is one of the indicators of the successful use of the process of digital transformation of the Russian economy.

This industry has a long history. In 1960, for the first time in the USA, CORONA satellite system was launched, under the guidance of the CIA Science Directorate and with the support of the US Air Force. A powerful impetus for this practical implementation of such program was the launch of the first artificial satellite *Sputnik* into orbit by the Soviet Union in October 1957. This was the beginning of the era of space reconnaissance, which anticipated the creation of the industry of Earth observation from space. In 1962, the USSR launched the first reconnaissance satellite Zenit-2 into orbit. It was designed similarly to the manned spacecraft Vostok by the Special Design Bureau No. 1 founded for the Development of Long-Range Rockets, headed by S.P. Korolev. Subsequently, in the 1960s, the idea of creating a civilian satellite for scientific research of the Earth's surface emerged in the USA, followed by a satellite program for Earth observation from space to gather information on the planet's natural resources and global climate change.

LANDSAT PROGRAM

In 1970, the US National Aeronautics and Space Administration (NASA) received approval to develop satellites as part of the Landsat pro-

[5] URL: https://base.garant.ru/136323/

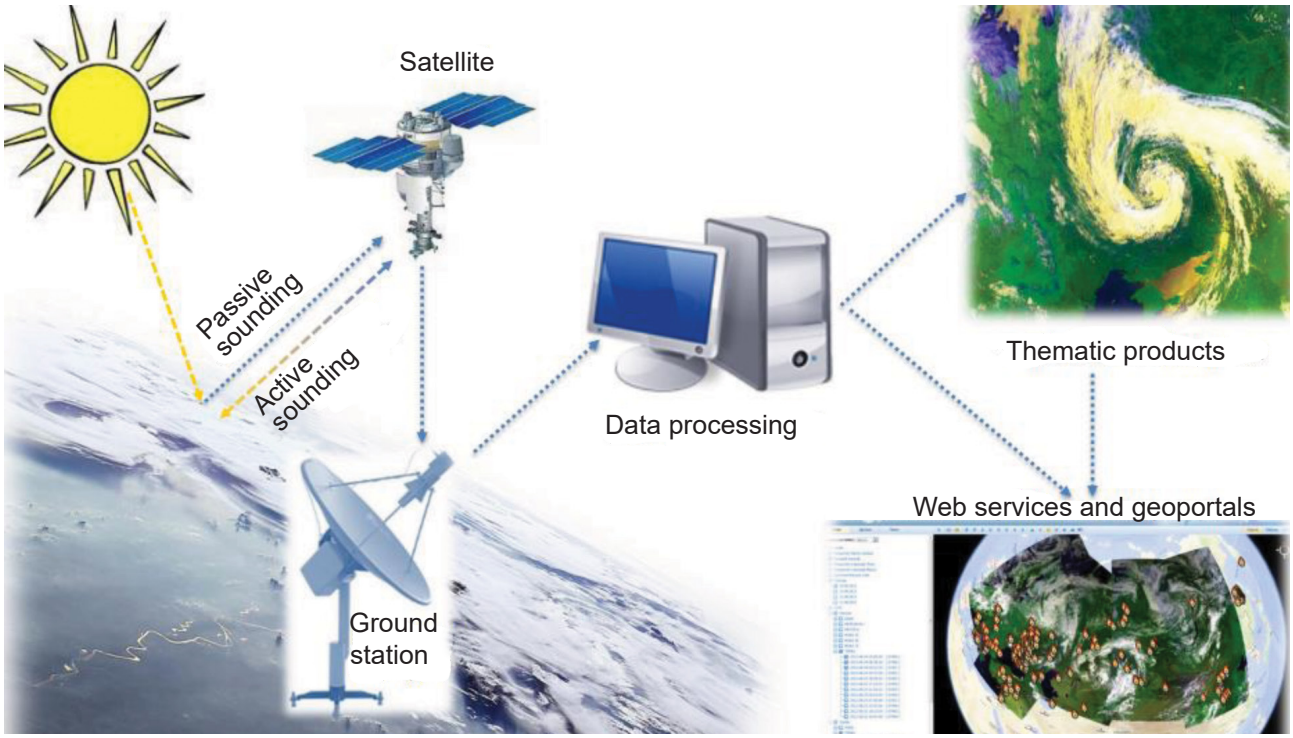

Fig. 2. **Diagram of Obtaining Earth observation Data, Processing it, and Delivering it to the End User**

Source: URL: http://mgmtmo.ru/edumat/satmet/ScanEx_2013.pdf

gram. The first of these series, Landsat 1, was launched in 1972 and was actively employed for public and research purposes until 1978 to be followed by Landsat 2 (1975–1983), Landsat 3 (1978–1983), Landsat 4 (1982–2001) and Landsat 5 (1984–2013). The currently active satellites still in orbit under this program are Landsat 7 (launched 1999), Landsat 8 and Landsat 9 (2013 and 2021 respectively).[6] By the year of 2030, the US plans to launch Landsat Next, a so-called constellation of three satellites. They are expects to be able to collect 15 times more data.[7] Today, they obtain the data used for agriculture and forestry, geology and cartography, detection of natural disasters, research and education.

The Landsat program in the United States has accumulated substantial archives of earth observation data, as shown in *Fig. 3*.

Landsat has become an example project of the Open Data policy. Since 2008, it has been freely accessible via Internet on-line connection on a non-discriminatory basis [3], which has contributed to the emergence of new technological solutions, the expansion of scientific research, business development, as well as the creation of services and operational applications for government agencies, as well as the private sector and civil society.

Russia in the global segment of Earth observation from space

Experts state, that the Russian Federation ranks fourth in the world after the United States, China and the United Kingdom with a significant lag behind the leaders in terms of the number of satellites in orbit. Russia's share in the world orbital constellation is less than 2.5 per cent [4]. According to experts, due to the intensification of international competition, by the year of 2030,

[6] URL: https://landsat.gsfc.nasa.gov/satellites/

[7] URL: https://landsat.gsfc.nasa.gov/satellites/landsat-next/

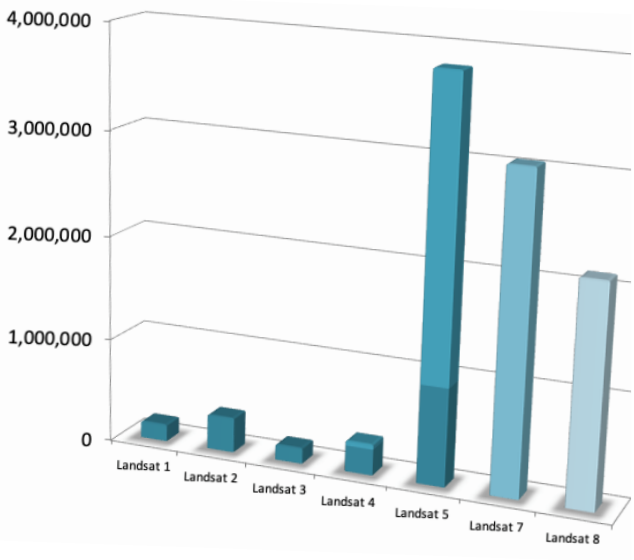

Fig. 3. **Landsat Data in the U.S. Archive (as of September 30, 2021)**

Source: URL: https://landsat.gsfc.nasa.gov/satellites/landsat-9/

the volume of the global market for Earth observation data will grow more than three times compared to 2020.

According to the global statistics, as a whole, 319 earth observation satellites were launched worldwide by 2023 [5, p. 5], of which 301 are still operating successfully by now. China and the USA take on the leadership in the production and operational management of Earth observation space systems. In 2023, China launched 119 satellites (40 per cent of the total) and the USA 103 (34 per cent) [4, p. 5].

The Russian Federation has put into orbit 9 earth observation satellites [4, p. 5], which makes nearly 3 per cent of their total number in orbit. In the segment of Earth observation from space, the Russian Federation has the following series of satellites Resurs-P, Kanopus-V, Meteor-M, Elektro-L, Arktika-M, Kondor-FKA.[8]

The outer space monitoring carried out by the Resurs-P complex is aimed for the research purposes and control measures to obtain data by means of "exploration of natural resources; control of environmental pollution and degradation, identification and study of environmental contamination, control of water protection and protected areas; information support for the search for mineral resources; assessment of ice conditions; inventory of natural resources to ensure rational activities in various sectors of the economy; monitoring of emergency situations; information support for engineering surveys; creation and updating of cadastral, topographic and navigational maps; determination of the type and condition of vegetation, the composition of the pollution film on the surface of the water, identification of minerals, soils; detection of illegal crops of drugs and controlling their eradication, etc."[9] The Ministry of the Russian Federation for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters, Ministry of Natural Resources and Environment of the Russian Federation, Roshydromet, as well as commercial entities, obtain the data from the Kanopus-V series comet satellites as a valuable source of information. Low-orbiting meteorological satellites Meteor-M series are designed to "receive space data for operational meteorology, hydrology, agro-meteorology, climate and environmental monitoring, including near-Earth space".[10] The main mission of the Electro-L geostationary hydrometeorological space complex is to provide data obtained related to synoptic analysis, global weather forecasting and forecasting for aviation, climate change monitoring and environmental control in industrial areas. The Arktika-M series of satellites provide "round-the-clock all-weather monitoring of the Earth's surface and the Arctic Ocean waters, as well as continuous and reliable communications and other telecommunications services".[11] The only radar satellite, Kondor-FKA, launched in

[8] URL: https://ntsomz.ru/remote_sensing_spacecraft/; URL: https://www.roscosmos.ru/24707/

[9] URL: https://www.roscosmos.ru/24984/

[10] URL: https://www.roscosmos.ru/37906/

[11] URL: https://www.roscosmos.ru/28966/

the year of 2023, provide all-round-weather monitoring throughout the Earth's surface.

However, the existing Russian equipment does not fully meet the needs of domestic users. The information obtained from foreign providers is quite expensive. Besides, the access to some information from abroad is severely restricted due to anti-Russian sanctions and the terms of licensing agreements. For example, in 2022, the largest foreign operators of earth observation from space: Maxar Intelligence[12] (USA), Airbus Defence & Space[13] (France), SI Imaging Services[14] (South Korea), Deimos Imaging[15] (Spain), and Capella Space[16] (USA), etc., stopped providing space image data to the Russian Federation [6]. This resulted in a significant deficit of data needed for effective functioning of domestic government agencies and commercial enterprises in various sectors of the economy. Insufficient resource support, as well as lack of appropriate knowledge, skills and abilities, backward ways to obtain information in the field under study, underestimated effectiveness of using Earth observation technologies can lead to untimely forecasting, detection and prevention of emergency situations, internal and external threats to food security, etc. Therefore, it is necessary to provide government agencies and commercial enterprises with information obtained from Russian satellites, which requires expanding the Russian fleet of Earth observation satellites.

[12] Maxar Intelligence is a US company that has developed the latest WorldView Legion satellites for high quality Earth observation.

[13] Airbus Defence & Space is a division of the Airbus Group responsible for defence, space products and services.

[14] SI Imaging Services is the provider of earth observation data from Korea's KOMPSAT series of satellites (KOMPSAT-2, KOMPSAT-3 optoelectronic satellites and KOMPSAT-5 radar satellite).

[15] Deimos Imaging is the company, which was founded as a result of collaboration between the Spanish aerospace company Deimos Space and the Earth observation Laboratory of the University of Valladolid. It develops, implements, operates and commercialises the Earth observation systems.

[16] Capella Space, also called called Capella 36, is an American aerospace company specialising in earth observation from space, mainly for defence and security purposes; high periodicity is achieved be means of the phased deployment of an orbital constellation of 36 radar observation satellites.

According to experts, "the development of the production capabilities of the rocket and space industry, the introduction of assembly-line production and the involvement of private companies in the development of satellite will make it possible to increase the scale of the Russian orbital constellation by 15 times by the year of 2036".[17] According to the Unified Plan for Achieving the National Development Goals of the Russian Federation to 2030 and in the Perspective to 2036, "the key factor to obtain technological independence in the field of advanced space technologies and services will be to ensure, that the Russian Federation achieves technological leadership in space activities, including by increasing the production of Russian satellites as a result of commissioning assembly lines in the rocket and space industry enterprises".[18]

Promising space systems and services

One of the global trends is the involvement of the skills and capabilities of the private sector in solving government tasks. For example, the private-public partnership model is typical for the space industries in some countries: for example, the US Department of Defence successfully operates in the field of Earth observation from space. The key factor to the implementation of private-public partnership for the space industry projects is the availability of developments and specific competences for private companies needed by the State to provide high-quality public services, which in turn stimulates research and development and the innovation process in the industry as a whole. In addition, such mechanisms can achieve greater feedback on research financing and successfully maintain the issue of subsequent commercialisation of results.

Today, the US space industry most actively accomplish the projects of the private-public

[17] URL: https://www.interfax.ru/russia/938056

[18] URL: https://base.garant.ru/411256963/

partnership model in the areas of satellite telecommunications, Earth observation, and space transportation. "In the recent years, the private-public partnership model mechanisms in the US have been actively improving and acquiring new features due to the sharp increase in the number of participants in space activities and the range of services they provide" [7, p. 80].

To achieve acceleration of technological development, national technological sovereignty and technological leadership of the Russian Federation in the international arena, a high-tech direction roadmap "Advanced space systems and services" for the period up to 2030[19] was approved by the Decision of the Presidium of the Governmental Commission for Economic Modernisation and Innovative Development of Russia No. 2 dated 29.12.2022. In order to implement it, the Government of the Russian Federation has issued Order # 3926-r of 15.12.2022 "On Approval of the Standard Form of Memorandum of Understanding between the Government of the Russian Federation and an Interested Organisation for the Development of a High-Tech District".[20]

The total amount of funding for all activities of the roadmap until 2030 is planned to

be nearly 480 billion roubles, including about 370 billion roubles from the budget and the rest from extra-budgetary sources. Part of the state funds will go to purchase Earth observation data from private companies, which in turn will have to invest in the development of new satellites. By the year of 2030, more than 60 Earth observation satellites and over 700 communications satellites are expected to be in orbit [8].

Another promising direction of the Russian space industry aimed at achieving technological sovereignty may be the Sphere project. Within the framework of this project, orbital communication constellations will be created with Yamal,[21] Express, Express-RV,[22] Skif[23] and Marathon,[24] as well as orbital constellations for Earth observation with optical-electronic and radar observation satellites

Pixel-VR, Berkut-VD,[25] Berkut-X,[26] Berkut-XLP, Berkut-C[27] and Smotr.[28] Thus, the launch of 360 satellites is planned by 2030, which will provide full coverage of the country's territory with all modern space services.

CONCLUSIONS

Nowadays, the Russian space industry is facing the challenges of significant expanding of the use of key space services for citizens, government agencies and business companies, in the spheres to provide high-quality communications coverage of the entire territory of the Russian Federation and geo-information products and Earth observation technologies. The comprehensive use of space monitoring tools opens up

[19] URL: https://www.roscosmos.ru/media/files/2023/perspektivnie.kosmiceskie.sistemi.i.servisi.pdf

[20] URL: https://www.consultant.ru/document/cons_doc_LAW_434521/

[21] "Yamal" is the common brand name for geostationary communications and direct broadcast television satellites owned by Gazprom Space Systems JSC. One of the promising Yamal-502 satellites to be launched in 2028 and provide satellite broadband services for mass users and communications for mobile projects, such as commercial aviation, shipping, road and rail transport.

[22] Express-RVs are advanced satellites developed by Information Satellite Systems named after Academician M.F. Reshetnev, that will provide communications, including broadband Internet access throughout Russia and the Arctic Ocean. The launch of the first satellite planned for October 2025, deployment of the full orbital constellation planned for 2026.

[23] Skif is a satellite communications system designed to provide broadband internet access.

[24] Marathon is a series of advanced satellite designed to organise data transmission around the Earth. The full Marathon orbital constellation will include more than 260 satellites.

[25] Berkut-VD is a promising space system for operational monitoring of the Earth's surface with a linear resolution of 1 metre.

[26] Berkut-X is a promising space system for all-weather radar monitoring of ice conditions on the Northern Sea Route, including control of hazardous production facilities.

[27] Berkut-S is a promising low-orbit satellite communications system for data exchange between automated objects in the Earth segment and for high-speed access to information networks, including the use of subscriber equipment operating in cellular networks.

[28] Smotr is a promising space system for highly detailed observation and monitoring of greenhouse gas emissions and methane leakage; URL: https://www.roscosmos.ru/39138/

opportunities to solve more effectively tasks in the area of the State and municipal administration, territorial organisation and development of transport and logistics corridors, solving environmental problems and development of various economic sectors, including such promising industries as robotics, data economy, etc. The use of space monitoring tools opens opportunities for more effective solutions of tasks in the area of state and municipal administration, territorial organisation and development of transport and logistics corridors. In the interests of the State, the economic efficiency of the use of information obtained by Earth observation from space will reduce labour costs and shorten time to obtain information on territorial processes and make management decisions, including in crisis situations. It will increase tax revenues from the use of resources, real estate complexes, or land, increase in efficiency, effectiveness and quality of State and municipal management, information openness, as well as the attractiveness of investment and the competitiveness of the regions.

In order to achieve the abovementioned tasks it is necessary to:

- increase furthermore the output of the orbital constellation of satellites, including specialised in Earth observation;
- implement the idea of conveyor production of satellites, which will reduce the cost, labour intensity and time for construction of satellites;
- implement private-public partnership projects in the space industry to attract investments and skills from private companies.

Successful implementation of these promising projects for the Russian Federation may ensure independence in providing government agencies and private companies with the necessary space data and services, as well as achieving technological sovereignty in one of the key sectors of the Russian economy.

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Increasing the Efficiency of Solar Electric Power Utilization

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ABSTRACT

The relevance of the study is driven by the rapid development of solar energy and the search for opportunities to increase its efficiency in order to ensure a more stable energy supply for the population and improve the quality of life. **The objective:** to identify the key features of the global experience in using solar trackers for power generation. **Research methods:** mathematical analysis, empirical data analysis, systematization, investment analysis. **Findings:** this study examines various types of solar panels and their impact on the economic efficiency of solar energy projects. A review of relevant literature and scientific-practical studies confirms the versatility of solar trackers in different geographical and climatic zones. The study includes calculations of key investment attractiveness indicators for projects utilizing solar trackers and stationary systems, demonstrating the low efficiency of the latter. Key directions for the development of this technology have been identified, and recommendations for its improvement are provided. **Practical significance:** the main conclusion of this study may be useful for justifying the feasibility of using trackers at solar power plants and for exploring ways to improve the efficiency of solar generation.

Keywords: global economy; renewable energy sources; predictive analytics; solar trackers; investment analysis; international cooperation

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INTRODUCTION

The modern economy requires significant energy consumption for its development. This makes it necessary to find ways to provide energy from both traditional and renewable energy sources (RES). Nowadays, the fastest growing type of renewable energy sources has become the solar energy and by 2023: its share in the global production exceeds 5.5 per cent.[1] The Russian Federation considers the development of renewable energy sources as one of the top priority energy tasks. This is why it is important to study this issue taking into account the country's specifics and the possibility of applying global experience. Currently, Russia has a Renewable Energy Support Programme for the period of 2025–2035, according to which an additional 3.5 GW of solar power plants (SPP) are planned to start operating by the year of 2035.[2] This increases the relevance of studying this issue.

The rapid development of solar energy would be possible with permanent technological innovations implemented in the industry. One of them is the tracking systems, or solar trackers. Prior to 2008, all solar power plants were equipped with static or stationary modules that were oriented at a fixed angle and could not change their position to follow the sun. The main requirement for the installation of such panels is the direction of their inclination to the equator: towards the South in the northern hemisphere and the North in the southern hemisphere. This has resulted in significant losses due to weather conditions, season and other factors [1]. Besides, since the peak of energy production was only in the middle of the day, this would not ensure stability level and significant fluctuations in the market value of the energy were inevitable throughout the whole day. Nevertheless, the advantage of such panels is the capability to set a higher peak power, which increases the total energy generation per panel area. Besides, due to the shading effect between panel rows, the distance between these rows can be reduced by increasing the number of panels.

The first devices to overcome the problem of energy production losses due to the movement of the sun were invented in the 1980s. The so-to-say "East-West configuration" positioned solar panels so, that modules were installed very close together. This minimised the space between the panel rows and maximised output in areas with limited space (which is common for the Northern Europe). In addition, the sun rises low above the horizon in the northern latitudes, which allows to position the panels closer to buildings without shading them and closer to the ground, reducing the wind pressure effect. Unlike previous conventional solar modules, East-West modules provide much better stability of energy production throughout the day, significantly reducing the risks of inverter overloads at midday.

In 2008, photovoltaic panels began to be widely deployed. They can rotate throughout the daylight hours to track the sun's movement across the sky and maximise energy production. However, increasing the number of solar panels not only increases the economics of solar energy systems (SES), but also creates long rows of trackers that are not suitable for locations of limited territories. In addition, at low panel angles, some of the benefits of tracking systems are lost due to backward algorithms.[3]

In recent years, the problem of improving the economic return of solar energy projects has been scrutinised by many Russian scientists [2–4]. They analysed the problems of separate regions and the possibility of increasing production in various subjects of the country [5–7]. Foreign scholars also developed he technical and economic aspects of this issue. [11–13]. Despite the ambiguous attitude to solar trackers, notably, that the most important economic effect of their introduction, due to a sharp increase in the efficiency of the panel, is

[1] URL: https://rspp.ru/document/1/2/5/2502ae1262d70e4e020677e29ad60c23.pdf

[2] URL: https://rspp.ru/document/1/2/5/2502ae1262d70e4e020677e29ad60c23.pdf

[3] URL: https://www.woodmac.com/reports/power-markets-global-solar-pv-tracker-landscape-2023–150186928/

a significant reduction in the cost of electricity. Thus, truckers reduce operating costs and provide an opportunity to reinvest the released funds to upgrade facilities for its production. For this reason, the technology under consideration requires a more detailed study.

ASSESSING SOLAR TRACKER PERFORMANCE ACCORDING TO LEVELISED COST OF ENERGY

To determine this economic impact, it is necessary to compare the cost of electricity generated by solar energy systems with and without solar trackers. The most appropriate indicator for comparison is levelised cost of energy (LCOE). the normalized, or, in other words, levelised cost of electricity over the life of the generating asset (usually measured in US$/kWh). This indicator is much more accurate than cost per 1W, because it takes into account many different factors that are particularly important for a particular industry. In the context of the solar industry, the calculation of the normalised cost of electricity takes into account the following factors: panel cost, panel performance, system cost and maintenance cost. In this respect, the analysis of levelised cost of energy (LCOE) is best suited for both studying the dynamics of electricity costs in general and comparing them between different energy sources.

Table 1

Forecasted LCOE for Solar Panels Without Tracking (USD/MWh)

Country / Year	2022	2023	2024	2025	2026	2027
Argentina	74.06	50.69	40.48	34.58	31.80	29.71
United Kingdom	54.48	51.90	49.15	47.12	45.00	43.39
Germany	48.05	45.16	42.74	41.19	39.41	38.06
India	36.42	35.28	33.85	32.47	30.78	29.22
Indonesia	78.51	62.74	54.13	48.61	45.39	42.79
Spain	37.40	34.65	32.62	31.31	29.85	28.74
China	37.28	35.26	33.49	31.91	30.79	29.76
UAE	38.33	33.25	30.06	28.06	26.50	25.32
USA	47.66	42.20	39.97	35.56	34.53	33.13
Turkey	34.59	33.28	31.20	29.59	28.61	28.12
Philippines	83.87	66.90	57.48	51.45	48.06	45.32
France	39.31	36.93	34.96	33.70	32.25	31.14
Chile	32.40	28.88	26.53	24.99	23.76	22.83
SOUTH AFRICA	48.51	39.43	34.79	32.06	29.79	28.13
South Korea	82.37	71.80	64.62	60.20	56.79	54.17

Source: compiled by the author based on BloombergNEF forecasts: URL: https://about.bnef.com/blog/2h-2023-lcoe-update-an-uneven-recovery/

Since stationary solar panels have been deployed much earlier than trackers, they were geographically spread wider, despite the higher normalised electricity costs, due to lower efficiency and higher losses. In 2023, the normalised cost of electricity for non-tracking systems ranges from 28.88 US$/MWh in Chile to 71.8 US$/MWh in South Korea. Turkey, the United Arab Emirates and Spain are also among the leaders in terms of levelised cost of energy for stationary solar panels. It is worth noting, that despite the rather high indicator of levelised cost of energy in 2022–2023, according to Bloomberg forecasts, the indicator is expected to decrease significantly in 2024–2027, making it possible to reach cost-effective levels (compared to other energy sources) (*Table 1*).

Thus, countries such as Argentina (–59.88%), the Philippines (–45.96%) and Indonesia (–45.5%) are expected to achieve the highest cost reductions for non-tracking solar panels over the period. However, Argentina will be the leader in terms of change and also in absolute terms if the current forecast is met, with normalised costs decreasing from 74.06 to 29.71 US$/MWh over the 5-year period. Argentina will also lead the change in absolute terms if the current forecast is met, reducing normalised costs from 74.06 to 29.71 US$/MWh over 5 years (–US$ 44.34/MWh). For all countries using solar panels without tracking, the LCOE would decrease by an average of 32.9%. Although the data analysed represents a predicted development scenario, the dynamics of the last three years and increasing government support increase the probability of its realisation.

The normalised cost of electricity for solar panels with tracking is on average lower than for panels without tracking, but the geographical scope of their use is much smaller. At the end of 2023, LCOE values ranged from 26.3 (Chile) to 44.56 (Colombia). LCOE values range from 26.3 (Chile) to 44.56 (Colombia) US$/MWh. Spain, Turkey and Mexico also become leaders in reducing rationed costs. Similar to the LCOE dynamics for solar panels without tracking, trackers are also characterised by a stable decrease in normalised electricity costs in all countries during 2024–2027, according to Bloomberg forecasts (*Table 2*).

Table 2

Forecasted LCOE for Solar Panels With Tracking (USD/MWh)

Country / Year	2022	2023	2024	2025	2026	2027
Australia	47.68	38.51	33.65	30.68	28.47	26.78
Brazil	47.57	37.88	32.74	29.64	27.51	25.94
Spain	32.56	30.07	28.26	27.09	25.79	24.80
Colombia	53.91	44.56	39.46	36.18	33.77	31.93
Mexico	37.58	31.38	27.94	25.76	24.12	22.89
USA	42.45	38.38	35.52	31.83	30.94	29.76
Turkey	32.14	31.01	29.07	27.56	26.66	26.21
Chile	30.30	26.30	23.81	22.20	21.12	20.30
South Africa	41.98	34.13	30.11	27.74	25.81	24.38

Source: compiled by the author based on BloombergNEF forecasts: URL: https://about.bnef.com/blog/2h-2023-lcoe-update-an-uneven-recovery/

Brazil (–45.46%), Australia (–43.84%) and South Africa (–41.92%) will experience the largest decrease in LCOE for solar trackers, according to forecasts. At the same time, in absolute terms, if the forecast is correct, Colombia will have the best result (–21.62 US$/MWh). Meanwhile, Chile is expected to maintain its position as the country with the lowest LCOE in the whole list of leaders. On average for all countries, this indicator will fall by 35.1 per cent. Thus, the normalised cost of electricity for systems with tracking is lower both from the year of 2023 and throughout the forecast period to 2027. The current government policies of the countries under consideration and the dynamics of 2022–2023 allow us to make a conclusion that it is highly feasible that the projected values are quite realistic. It is particularly important to note that the significant difference in LCOE between fixed panels and trackers is also characteristic in each country under consideration. In the USA, for example, the LCOE in 2023 for the former is US$ 42.2/MWh, while the LCOE for the latter it was US$ 38.38 / MWh, another words, 9 per cent less. This indicator confirms the economic efficiency of solar trackers for the country's energy system.

At the same time, geographical, climatic, legislative and other peculiarities have become an important aspect. To analyse the normalised costs, the author has selected only the leading countries involved in electricity generation with the help of solar energy systems. Some other countries provide no publicly available information on energy costs, or their data vary significantly from region to region. To analyse the global experience with solar panels with and without tracking systems, the author of the study considered two countries from two different geographical regions in Asia and Africa.

RESULTS OF THE USE OF SOLAR TRACKERS IN SOUTH KOREA

South Korea actively developing solar energy was under study for the analysis among the Asia-Pacific (APAC) countries. Having ratified the Paris Agreement in 2016, South Korea set up the renewable energy sources share at 40 per cent of total public sector energy production, which caused some challenges for further increase of its capacity of total electricity generation. Since 2014, the country has pursued a policy of supporting the development of renewable energy sources, which has led to a rapid increase in the capacity of electricity generation. At the same time, solar power has become the national top priority source (*Fig. 1*).

Over the ten-year period (2013–2023), the cumulative installed capacity of solar energy systems increased by more than 20 times, meanwhile the other types of renewal energy systems remained at about the same level. This indicates that solar energy has become a priority energy source for the South Korean economy. The State support has greatly contributed to such a rapid growth: the government covered up to 80 per cent of installation costs. However, this only applies to the experience of stationary photovoltaic panels. Solar trackers are seldom visible in the country due to the high initial investment cost and lack of domestic technology research. In addition, Korean experts consider stationary systems more reliable from their maintenance point of view.

To overcome these drawbacks, it is required to run a continuous cost analysis of solar trackers for an improved generation of energy. In 2011 and 2017, South Korea carried out a research work. Initially, in theory local experts believed, that the cost of a tracked system and a conventional system could be the same [14]. The proposed solar panel system was quite small, so that it could be mounted on walls, which reduced the area required and the initial project investment. Later, economic aspects of installing photovoltaic panels were evaluated by comparing the investment performance of the projects.

According to the obtained results, depending on the season and geographical conditions, the use of solar trackers can contribute to the growth of energy production from 10 to 100 per cent, if compared to stationary panels [15]. Moreover, eco-

nomic analyses confirm the superiority of tracking systems in terms of cost and environmental impact (*Fig. 2*).

Thus, we can make a conclusion, that the production capacity of solar trackers is significantly higher than those fixed solar systems operating at the most commonly used tilt angles (30–60°C), which confirms the relevance of this technology for South Korea.

POTENTIAL FOR THE USE OF SOLAR TRACKERS IN THE REPUBLIC OF GHANA

We made a research of this aspect for the Republic of Ghana, one of the largest per capita electricity consumers in sub-Saharan Africa. Unlike its neighbouring countries, Ghana has been able to open access to electricity for almost 80 per cent of the local population, the best indicator in West Africa. This was the decision of the government to start developing renewable energy, but it is worth noting, that access to electricity does not mean a stable and sustainable energy supply. An excellent solution to the energy problem is the solar energy: its costs are steadily decreasing. In 2023, the African Development Fund (ADF) awarded Ghana a grant of 27.39 million US dollars to develop renewable energy mini-grids, based particularly on the solar energy. Ghana will install 35 photovoltaic systems in 400 schools, 200 in health centres and 100 in housing and utilities. Besides this, public institutions, small and medium enterprises and some households will be able to install 12,000 such solar systems on their roofs, with a planned installed capacity of over 67 MW.[4]

Despite the support from the African Development Fund and Ghana's active policy to develop the growing the solar market, problems still exist in the sector: the country requires proper technical equipment, knowledge and

[4] URL: https://www.mordorintelligence.com/industry-reports/ghana-solar-energy-market

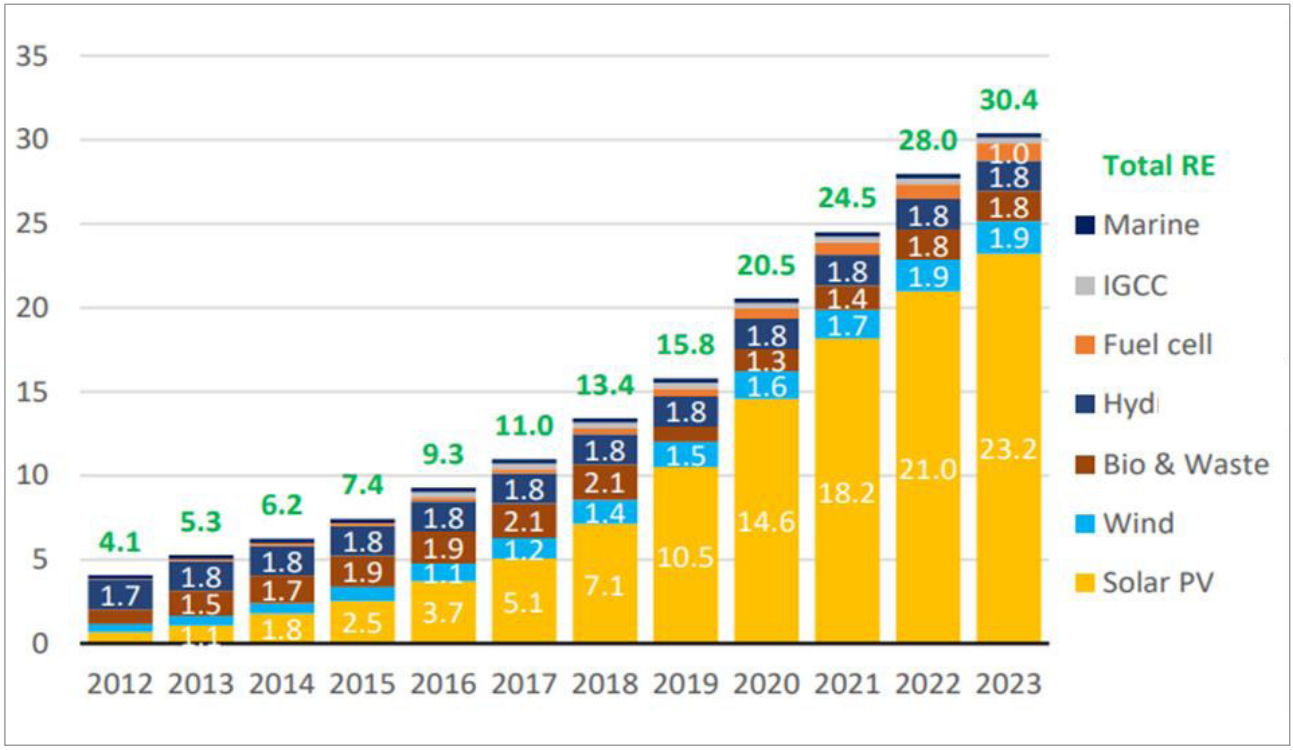

Fig. 1. **Dynamics of the Total Installed Capacity of Renewable Energy in South Korea, in GW**

Source: compiled by the author on the basis of: URL: https://www.renewable-ei.org/pdfdownload/activities/REI_SKoreaReport_202311_EN.pdf

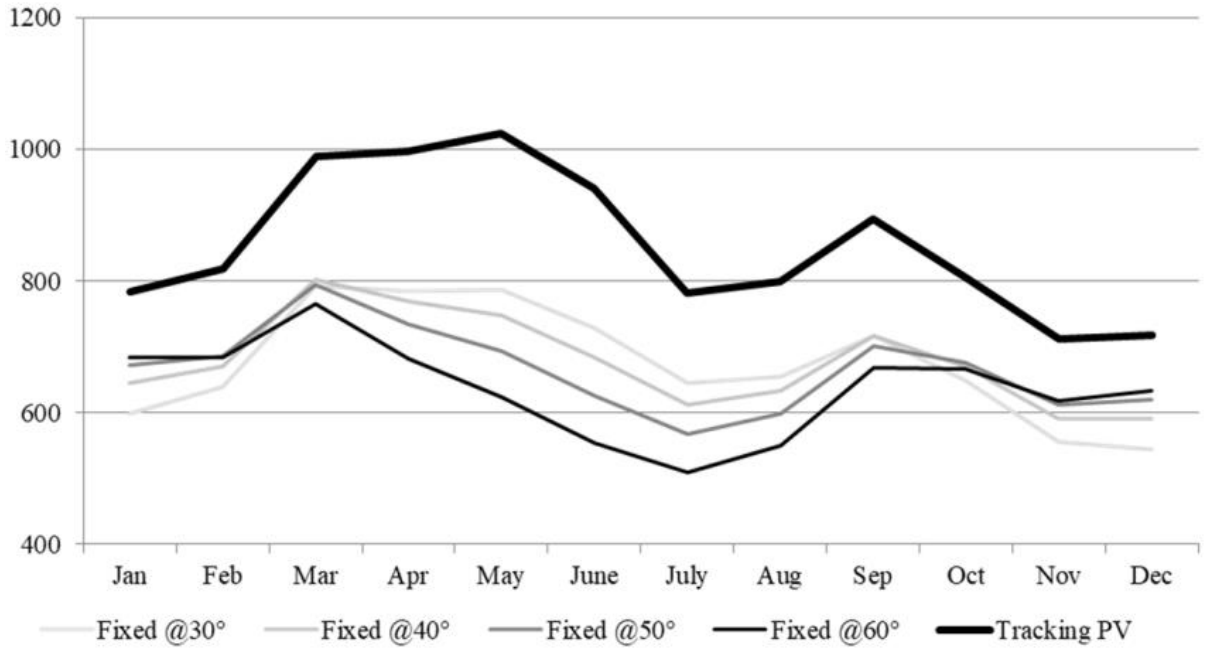

Fig. 2. **Electricity Production by Tracking Systems and Fixed Photovoltaic Panels in South Korea by Month, kW, 2023**

Source: compiled by the author on the basis of: URL: https://doi.org/10.3390/en16217338

skills that are still in short supply in the country. Many initiatives also lack funding due to the high cost of long-term solutions. Many products for photovoltaic systems are patented, interest rates are high and consumers lack the funds to invest in their own systems. Besides, after the installment of the panels, they require additional operating and maintenance costs. Hence, although the government supports the transition to renewable energy, proper legislation and regulations are still lacking in some areas. The government is aware of all these hindrances and is trying to find the ways to solve them, including by sharing experience and introducing the latest technologies.

The upgrading of solar panels with tracking systems can sparsely solve some of these problems. To assess their effectiveness, it is necessary to compare the investment indication of the same project using both systems. According to McKinsey, usually conventional solar trackers have been single-axis, horizontal or vertical. However, among the most common models have been dual-axis trackers, which move both horizontally and vertically, as well as multi-row trackers, which can accommodate multiple rows of solar panels. The latter systems make it possible to expand the capture of solar energy within the light day, thus maximising its output effect.

The process of fine-tuning of trackers' exposure required a whole complex of algorithms with various factors implemented in consideration: position of the sun, weather conditions, shading, etc5.[5] For the analysis of the solar power plant project in Ghana, experts made a research of both options of single-axis and dual-axis trackers. For comparison, the largest solar power plant in the Upper West region of the country was selected and for the indicators were used the payback period, net present value, greenhouse gas emission reduction, and energy production cost.

[5] URL: https://mckinseywell.com/products/solar-tracker-market-report-2023–2033

Table 3

Investment Performance Indicators of Solar Power Plants Using Fixed Panels and Solar Trackers

Tracker model / indicators	Payback period (in years)	Net present value (mln. US$)	Greenhouse gas emission (tonne/year)	Profit/ costs	Production costs of solar energy (in US$/kWh)
Fixed panels	17.1	–9.857	7127	0.24	0.151
Single-axis trackers	134	–4.564	8093	0.65	0.133
Dual-axis trackers	11.6	–3.660	22 762	0.72	0.13

Source: compiled by the author on the basis of: URL: https://www.vra.com/media/2020/pdd/35MWper cent20Solarper cent20Powerper cent20Projectper cent20-per cent20Upperper cent20Westper cent20Regionalper cent20Sitesper cent20-per cent20Stakeholderper cent20Engagementper cent20Plan.pdf

The total initial cost of all three projects was 43.12 million US dollars, including capital cost of 1.500 US$/kWh per each photoelectric module and an overall maintenance cost of 40 US$/year for all the three scenarios [16]. *Table 3* illustrates the results of the economic analysis for each scenario.

Based on the calculations in the *Table 3*, we can conclude, that there are absolute advantages for panels with solar trackers compared to fixed panels. The difference in indication from year to year is due to the difference in the intensity of solar exposure and the data on which is obtained using the tracking system. Particularly important is the reduced cost of the generated electricity, which mitigates the retail price of electricity to the public, and the reduction of greenhouse gas emissions, which will ensure that Ghana meets its Sustainable Development Goals.

CONCLUSIONS

Although solar power is the fastest growing source of renewable energy, a number of challenges require solution for its further development. One of them is the limited power generation due to the strong dependence on the light time of the day and the position of the solar panel. Most of all, this obstacle can be overcome by introducing tracking panels or trackers of the solar energy systems.

This article presents a comparative performance analysis, which shows that in the vast majority of countries under consideration, the normalised cost of expenditure for electricity generation with solar trackers is significantly lower. The result is a lower cost of electricity for the population, which contributes to improve the living standards of citizens and infrastructure.

In order to confirm the economic feasibility of introducing solar trackers despite high initial investments, the scientific research analyses the global experience of introducing this technology in South Korea and the Republic of Ghana.

Despite the Government support for solar energy development programmes, South Korea is experiencing serious problems in increasing solar energy generation. Stationary panels predominantly used in the power plant systems, cannot provide stable and constant power generation. In view of the country's limited land resources, solar trackers become a necessary technology for the further development of solar energy, especially considering the rainy summer seasons.

The situation is similar in the Republic of Ghana. Despite significant differences in geography and climate, the country needs likewise

to develop solar power generation technologies to reduce energy costs for the population and provide electricity to the entire territory.

Three investment scenarios of solar energy systems are under consideration in a real-world case study: fixed panel, single-axis and dual-axis trackers. Based on the calculation of the net present value, the payback period, the energy production costs and the economic result of the project, the research has revealed, that the fixed systems are the most economically unviable. Thus, it is more feasible to use solar trackers. Taking into account the global experience in different geographical and climatic zones, it becomes a universal recommendation to implement such traceability solar energy systems in most countries of the world.

International cooperation makes an essential element for such a transition. The main driver for the further development to use solar energy in the near future is joint projects, the activity of international organisations, exhibitions and conferences, as well as intergovernmental meetings to exchange the proper experience. International cooperation has already contributed to development, introduction of advanced tracked solar systems with lower installation and maintenance costs. Some of them partially have been put into operation. An all-round extensive work of major organisations in the field of renewable energy has confirmed the importance of deployment of widespread tracker to sophisticate this technology.

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ORIGINAL PAPER

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JEL F51, F52, O11

The Goals and Objects of the Strategic Development of the Russian Federation in the Face of Systemic Aggression

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ABSTRACT

Since 2014, the society and economy of the Russian Federation have been developing in a context of dynamically tightening multifaceted sanctions and the attempts of states hostile to the Russian Federation to isolate Russia internationally. For long-term successful development in such an environment, as well as in any other external and internal conditions, it is essential not only to address current challenges, but also to develop a strategy and strive to achieve strategic goals. The integral parts of the strategy are the following: selecting an object, examining its current state, analyzing the environment (or external context) of the object, and setting strategic goals. In this article, we will be discussing four objects: exports of the Russian Federation, imports of the Russian Federation, leading industries, border regions of the Russian Federation. The strategic goals of the first two objects are their development, while the third object is protection from external threats. Describing these objects, the author tried to show the role of exports and imports of the Russian Federation in the production and use of products and services, to specify the industries whose development will contribute to the growth of other sectors of the economy, to assess the development of the border regions of the Russian Federation to the country's economy development.

Keywords: The Russian Federation; strategy; economic development; exports; imports; types of economic activity; border regions

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OBJECTIVE — DEVELOPMENT OF FOREIGN TRADE

Our outstanding thinkers have repeatedly pointed out the hostile attitude of neighboring countries towards Russia [1–3]. This hostility was particularly evident after the return of Crimea and Sevastopol to the Russian Federation, and after the start of the special military operation, it escalated into an undeclared war. Speaking at the St. Petersburg International Economic Forum on June 29, 2022, the Chairman of the Constitutional Court of the Russian Federation, V.D. Zorkin, noted: "In fact, the West has unleashed an unprecedented hybrid (or, more precisely, systemic) war against Russia: on the battlefield, in the military-industrial complex, economy, politics, culture, sports, science, education, media, and cyberspace" [4].

The systemic struggle is also taking place in the sphere of foreign trade, the role of which for the economy, financial sector, science, and society of the Russian Federation is well-known. The development of foreign trade includes increasing the volumes of exports of goods and services, improving the product and geographical structure of exports and imports, as well as achieving and maintaining their desired balance and shares in the country's GDP.

The sanctions imposed on the Russian Federation by unfriendly and hostile states are intended to be long-lasting. A significant portion of these sanctions is aimed at reducing the volumes and deteriorating the structure of Russia's foreign trade. Therefore, to develop a strategy for its growth under these unfavorable conditions, it is necessary to identify the most vulnerable exported and imported goods and services that are subject to sanctions.

OBJECT — EXPORT

To identify the most sensitive products and services to export volume reduction in Russian foreign trade, we will use data from the 2019 interindustry balance of the Russian Federation (IOB), which is available on the website of the Federal State Statistics Service of Russia (Rosstat).[1] The balance includes 61 products (OKPD 2) and 61 industries (OKVED 2).

The calculations show that reducing the export of products presented in the interindustry balance by a fixed amount (for example, by 10%) affects the output volumes of these products differently. The top ten sectors (in order of reduction in the volume of gross used products) included the following [5]:

1. Mining and quarrying products
2. Chemical substances and chemical products
3. Basic metals
4. Coke and refined petroleum products
5. Transportation means and transport equipment,
6. Air and space transport services
7. Food products, beverages, tobacco products
8. Finished metal products, except machinery and equipment
9. Agricultural and hunting products and services
10. Land and pipeline transport services

The shares of these products in the total volume of their output in 2020 are shown in *Table 1*.

The existence of interindustry linkages leads to the situation where, for instance, a reduction in the production of mining and quarrying products due to decreased exports primarily results in a decline in the production of coke and refined petroleum products, machinery and equipment not categorized under other groups, land and pipeline transport services, warehousing, rental and leasing services, as well as auxiliary transport services. A decrease in the production of transportation means and transport equipment subsequently triggers a reduction in the output of, notably, basic metals, finished metal products (excluding machinery and equipment), computer, electronic, optical, and electrical equipment, as well as machinery and equipment not classified under other categories [5].

[1] URL: https://rosstat.gov.ru/statistics/accounts

Such consequences, arising from established interindustry relationships, must be thoroughly considered when formulating response measures to shifts in the structure of global trade, as well as to various restrictions and sanctions that impede the development of foreign trade in the country.

Table 1

The share of exports in the gross output of the Russian Federation's most sensitive to the reduction in exports of goods and services in 2020, %

Product	Share of exports
Mining and quarrying products	45.1
Coke and refined petroleum products	34.1
Basic metals	43.4
Air and space transport services	38.2
Chemical substances and chemical products	29.5
Transportation means and transport equipment, other	22.5
Finished metal products, except machinery and equipment	14.1
Land and pipeline transportation services	11.7
Agricultural and hunting products and services	11.2
Food products, beverages, tobacco products	10.0

Source: compiled by the author according to Rosstat's data. URL: https://rosstat.gov.ru/storage/mediabank/tri-2020.xlsx

Table 2

The sectors of the Russian economy which share of imported goods and services in the total volume of used country product exceeded 25% in 2020, %

Industry	Share of imports
Manufacture of textiles and articles, clothing, leather and leather products	63.5
Manufacture of machinery and equipment not included in other categories	61.1
Manufacture of computers, electronic, and optical products	58.7
Manufacture of electrical equipment	53.8
Manufacture of basic pharmaceutical products and pharmaceutical preparations used for medical purposes	50.5
Manufacture of furniture and other finished products	45.1
Manufacture of motor vehicles, trailers, and semi-trailers	37.4
Manufacture of rubber and plastic products	32.1
Manufacture of chemicals and chemical products	30,1
Manufacturing of other transport equipment and vehicles	26.4
Water transport activities	25.9

Source: compiled by the author according to Rosstat's data. URL: https://rosstat.gov.ru/storage/mediabank/tri-2020.xlsx
Note: total product usage = used domestic products + used imported products.

OBJECT — IMPORT

Table 2 presents the top 11 industries with the largest share of imported products in their total output, as compiled from data provided by Rosstat in the "Table of Use of Goods and Services at Basic Prices for 2020" and the "Table of Use of Imported Products for 2020".

The task of reducing the "share of imports of goods and services in the structure of gross domestic product to 17 percent by 2030", as set out in the Decree of the President of the Russian Federation dated May 7, 2024, No. 309 "On National Development Goals of the Russian Federation for the Period Until 2030 and Prospects Until 2036",[2] can be addressed in different ways:

reduce the scale of imports of goods more than the decrease in GDP;

reduce the scale of imports of goods while maintaining or growing the existing GDP;

increase the scale of imports with a greater increase in GDP.

In the first and second cases, it would be advisable to reduce the volumes of imports of the goods and services listed in *Table 2*.

OBJECTIVE — DEVELOPMENT OF DOMESTIC PRODUCTION

Object — Leading Industries. Industries where an increase in the growth rates of output volumes is not tied to other industries and simultaneously contributes to the growth of these industries will be called "locomotives". The calculations made using data from the Russian interindustry balance allowed for their identification [5]:

- crop production and animal husbandry, hunting and related services in these areas;
- manufacturing of motor vehicles, trailers, and semi-trailers;
- mining and quarrying;
- development of computer software equipment, consulting and related services in the field of information technology;
- information technology activities;
- manufacturing of computers, electronic, and optical products.

At the same time, to increase the output volume of construction products by *d* percent, the production of products and services in 18 types of economic activities needs to increase by more than this value. In the case of public administration and military security, a leading growth in 27 types of economic activities, including construction, is necessary.

Data from the 2020 input-ouput balance show that these "locomotive" industries are oriented towards the export of the products they create and are significantly dependent on imports from abroad (*Table 3*). Furthermore, their total share in Russia's overall imports in 2020 was 1.8 times larger than in exports and 2.3 times higher than their share in the gross output of products and services[3] (*Table 4*).

The data from the tables demonstrate that the growth dynamics of leading industries depends on the state of global markets, the share held by Russian companies on those markets, their success, the availability of international payment systems, exchange rates, and logistical capabilities.

OBJECTIVE — PROTECTION OF TERRITORY

Object — Border Regions of the Russian Federation. In his speech at the plenary session of the St. Petersburg International Economic Forum on June 17, 2022, V. V. Putin warned: "We will face many challenges, risks, and factors that are difficult to predict and anticipate today".[4]

Modern Russia shares borders with 18 countries [6]. The study, the results of which are presented in this work, had two objectives: to assess the importance of groups of border regions of the Russian Federation for the economy of the Russian Federation and to show the dynamics of selected indicators of significance (importance) in 1998–2022. In

[2] URL: http://www.kremlin.ru/events/president/news/73986

[3] Gross output = used in production (intermediate consumption) + final consumption expenditure + exports of goods and services.

[4] URL: http://kremlin.ru/events/president/news/68669

Table 3

The share of exported goods and services of the Russian locomotive industries in gross output and the share of imported products in the total volume of use of these products in 2020, %

Products and Services	Share of Exported Products	Share of Imported Products
Agricultural and hunting products and services	11.2	11.6
Transportation means and transport equipment	4.8	37.4
Mining and quarrying products	45.1	2.5
Software products and software development services; consulting and similar services in information technology	12.3	14.3
Computers, electronic and optical products	5.3	58.7

Source: compiled by the author according to Rosstat's data. URL: https://rosstat.gov.ru/storage/mediabank/tri-2020.xlsx

Table 4

The share of the locomotive industries in the Russian Federation's total exports, imports, and gross output of goods and services in 2020, %

Leading Industries	Share in Output	Share in Exports	Share in Imports
Crop production and animal husbandry, hunting and related services in these areas	3.7	3.0	11.6
Manufactue of motor vehicles, trailers, and semi-trailers	1.4	0.7	3.9
Mining and quarrying	7.3	23.6	1.6
Development of computer software, consulting and similar services in information technology	1.5	1.6	2.2
Manufacturing of computer, electronic, and optical products	0.8	0.8	10.5
Total	14.7	29.7	29.8

Source: compiled by the author according to Rosstat's data. URL: https://rosstat.gov.ru/storage/mediabank/tri-2020.xlsx

2024, there were 44 border regions of the Russian Federation out of 89. Since the study covers the period from 1998 to 2022, the Donetsk People's Republic (DPR), Luhansk People's Republic (LPR), Zaporizhzhia, and Kherson regions are excluded, and the Voronezh and Rostov regions are added. Due to the lack of statistical data, the Republic of Crimea and the city of Sevastopol, as well as Samara region, are not considered because of the small length of the state border (70 km with the Republic of Kazakhstan). As a result, the sample of border regions includes 39 subjects. The data from the Federal State Statistics Service of Russia (Rosstat) were used as sources of information.

Six of the 39 regions of the Russian Federation are classified as regions with low socio-economic development (there are 10 such regions in total[5]),

[5] URL: https://www.economy.gov.ru/material/news/pravitelstvo_

39 are included in the list of 44 geostrategic[6] regions, and 3 are part of the 28 territories with advanced socio-economic development.[7] Border regions are present in all military districts[8] of the Russian Federation.

The main security threats in the border areas of the Russian Federation are outlined in the Foundations of the State Border Policy of the Russian Federation:

"a) Territorial claims of some neighboring countries and the possibility of conflicts and incidents on the state border associated with them;

b) Claims by foreign states and transnational corporations to strategic resources of the Arctic and the Far East;

utverdilo_finansirovanie_dlya_realizacii_individualnyh_programm_razvitiya_regionov_s_nizkim_urovnem_socialno_ekonomicheskogo_razvitiya.html

[6] URL: https://docs.cntd.ru/document/552378463

[7] URL: http://government.ru/docs/all/142378/

[8] URL: http://www.kremlin.ru/acts/bank/50360

Table 5

Armed invasion and infiltration of sabotage and reconnaissance teams of the Armed Forces of Ukraine on the territory of the Russian Federation

Administrative entity of the Russian Federation	Date of invasion
Belgorod region	22nd, 23d May 2023; 1st–5th June 2023
Bryansk region	2nd March 2023; 21st August 2024
Kursk region	6th August 2024; 18th September 2024

Source: compiled by the author based on Russian media.

Table 6

The macroeconomic indicators used and their designations

Indicator	Denotation
Annual average number of population, thou. persons	L
Average annual number of employed in the economy, thousand people	U
Annual average number of employed, thou. persons	R
Gross Regional Product, bln. roubles	X
Investments in fixed capital, mln. roubles	I
Fixed assets in economy, end of year, mln. roubles	F
Operational length of paved routes of federal, regional or inter-municipal and local significance, (end of year), km	Cr
Operational length of public railway tracks (end of year), km	Rr
Exports in actual prices, mln. USD	Ex
Imports in actual prices, mln. USD	Im
Money income of population, per month, bln. roubles	M

Source: compiled by the author.

c) Increased economic and demographic influence of foreign states on certain border areas with low levels of socio-economic development;

d) Intelligence and other activities of foreign special services and organizations aimed at destabilizing the socio-political situation in certain border areas due to unresolved socio-economic problems, religious and ethnic contradictions, and separatist manifestations among the population in these areas;

Table 7

Share of indicators of Russia's border subjects in total volume in 1998, 2013 and 2022, percent

Year	L	U	R	X	I	F	Cr	Rr	Ex	Im	M
1998	42.6	37.5	17.9	23.2	27.7	36.2	44.5	44.7	25.8	24.5	27.5
2013	39.8	37.3	17.4	28.5	34.7	28.6	45.2	48.0	20.8	18.9	32.7
2022	38.0	37.0	18.0	26.3	27.9	26.9	44.2	47.6	19.0	17.9	32.7

Source: compiled by the author according to Rosstat's data. URL: https://rosstat.gov.ru/storage/mediabank/tri-2020.xlsx

Note: The values of indicators "Exp" and "Imp" are given for 2021.

Table 8

Groups of border constituent entities of the Russian Federation and neighboring countries

Group Number	Russian regions	Neighboring countries
1	Republic of Karelia, Kaliningrad, Leningrad, Murmansk and Pskov regions	Kingdom of Norway, Republic of Finland, Republic of Estonia, Republic of Latvia, Republic of Lithuania, Republic of Poland
2	Belgorod, Bryansk, Voronezh, Kursk and Rostov regions	Ukraine (excluding Crimea and Sevastopol)
3	Krasnodar Territory, Republics: Dagestan, Ingushetia and North Ossetia – Alania; Kabardino-Balkarian, Karachay-Cherkess and Chechen Republics	Republic of Abkhazia, Republic of Georgia, Republic of South Ossetia, Republic of Azerbaijan
4	Astrakhan, Volgograd, Orenburg, Saratov, Kurgan, Tyumen (excluding Yamalo-Nenets Autonomous Okrug and Khanty-Mansi Autonomous Okrug), Chelyabinsk, Novosibirsk and Omsk regions; Republic of Altai, Altai Krai	Republic of Kazakhstan
5	Republic of Altai, Trans-Baikal, Primorye and Khabarovsk Territories, Amur Region, Jewish Autonomous Region	People's Republic of China (PRC), Democratic People's Republic of Korea (DPRK)
6	Republics: Altai, Tuva, Buryatia; Trans-Baikal region	Mongolia
7	Kamchatka Krai, Sakhalin Region, Chukotka Autonomous Okrug	USA, Japan

Source: compiled by the author.

e) Attempts to infiltrate Russian territory by members of international terrorist and extremist organizations, participants in illegal armed groups, as well as individuals who are banned from entering the Russian Federation;

f) Cross-border crime related to illegal migration, smuggling of weapons, ammunition, explosives, and toxic substances, narcotics, psychotropic substances and their precursors, material and cultural valuables, as well as illegal extraction and sale of aquatic biological resources;

g) The risk of natural disasters, technological catastrophes, epidemics, epizootics, and their potential cross-border spread in border areas of the Russian Federation and certain neighboring countries".[9]

This list does not include the "danger of armed invasion into the country". For example, in March 1969, the armed forces of the People's Republic of China infiltrated the Damansky Island (*Table 5*).

We will assess the significance of the selected border regions for the economy of Russia based on 11 macroeconomic indicators (*Table 6*). These include indicators characterizing productive forces (Pop, Empl, FA), overall development level (GRP), scientific potential (R&D), infrastructure (Road, Rail), purchasing power demand (MIP), and others [7].[10]

From 1998 to 2022, the share of the studied economic indicators of the selected border regions of the Russian Federation ranged from 18% to 48% of the total volume (*Table 7*), indicating their importance for the domestic economy. However, for 9 out of the 11 macroeconomic indicators, the share in 2022 was lower than in 2013.

[9] URL: http://www.kremlin.ru/acts/bank/43004

[10] The business activity index of the Institute of Economics of the Russian Academy of Sciences uses its own set of indicators to assess the impact of sanctions on business activity in the Russian Federation

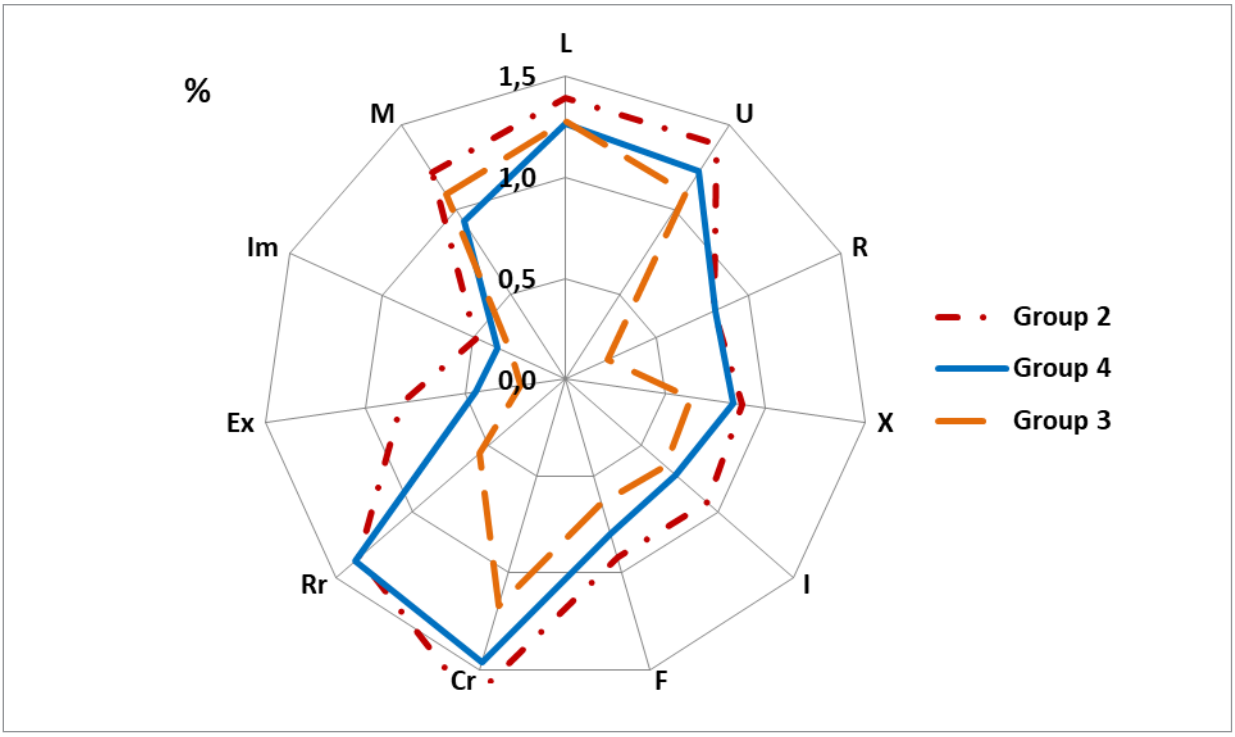

Fig. 1. **The Ratio of Indicators of Average Region to Total Volume in Russia in 2022, %**

Source: compiled by the author.

Note: The values of indicators "Ex" and "Im" are given for 2021.

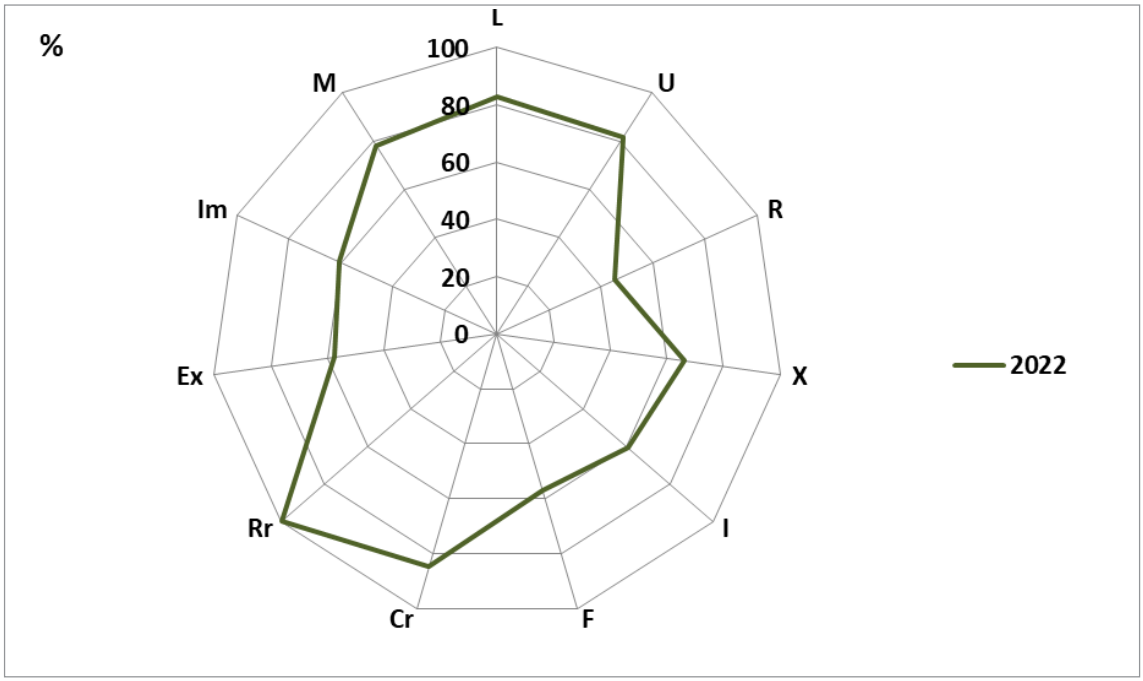

Fig. 2. **The Ratio of Indicator Values of Russia's border regions to Central Regions, %**

Source: compiled by the author.

Note: The values of indicators "Ex" and "Im" are given for 2021.

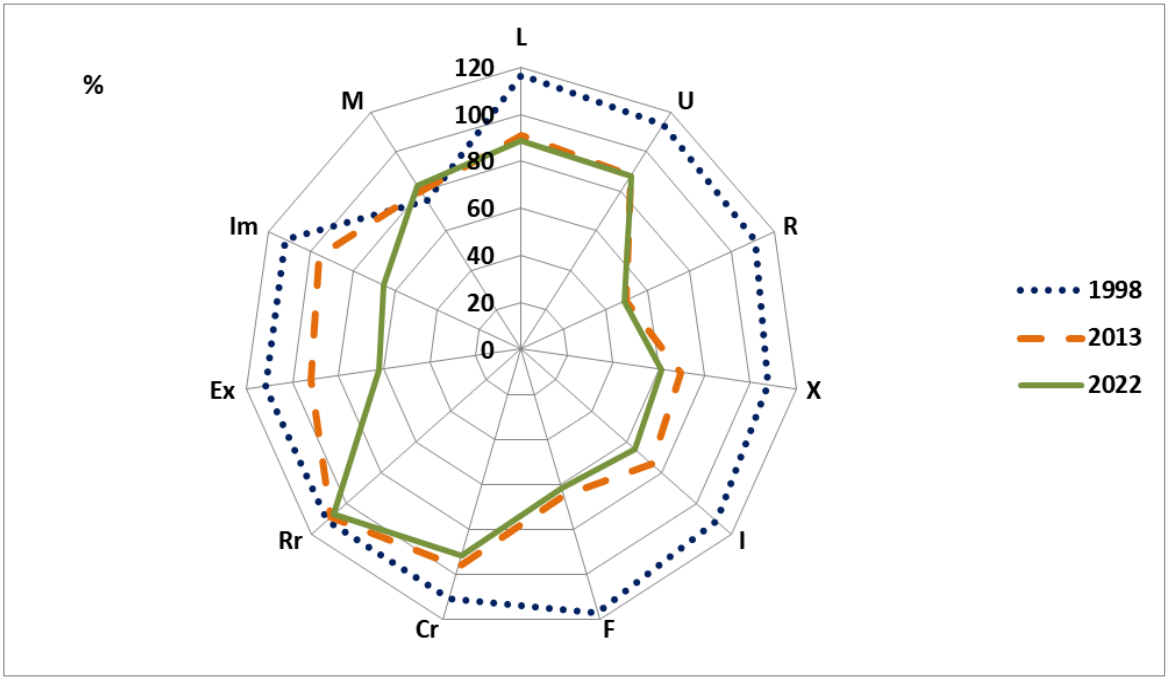

Fig. 3. **The Ratio of Average Indicators of Regional Groups to Nationwide Indicators in 2022, %**

Source: compiled by the author.

Note: The values of indicators "Ex" and "Im" are given for 2021.

Table 9

The top five and bottom five in the ranking of the border regions of the Russian Federation, 2022

Ranking based on 11 macro indicators	Ranking by the values of the final RIA ratings
Top five	
Krasnodar Territory Rostov Region Chelyabinsk Region Novosibirsk Region Leningrad Region	Krasnodar Territory Leningrad Region Tyumen Region without Khanty-Mansiysk Autonomous Okrug and Yamalo-Nenets Autonomous Okrug Rostov Region Chelyabinsk Region
Bottom five	
Karachay-Cherkess Republic Republic of Ingushetia Republic of Tuva Republic of Altai Chukotka Autonomous Okrug	Chukotka Autonomous Okrug Altai Republic Karachay-Cherkess Republic Republic of Ingushetia Jewish Autonomous Region Chukotka Autonomous Okrug

Source: compiled by the author.

From 1998 to 2022, the highest shares were recorded for the length of public roads (Cr) and railways (Rr), the population (L) and the number of employed people (U), and the monetary income of the population (M).

According to *Table 7*, significant changes occurred from 1998 to 2013 (before the introduction of anti-Russian sanctions): the shares of 5 indicators increased, while 6 decreased. After 2013, the values of 9 indicators decreased.

For further detailing the significance of the analyzed regions of the Russian Federation, they need to be grouped based on the foreign countries they border and their geographical location (*Table 8*).

We will evaluate the average significance of a region in each group. To do this, we will divide the shares of all the studied indicators for each group by the number of regions in that group. The resulting values will be taken as indicators of the significance of one (average) region of the group based on the analyzed indicators.

According to the calculations, in 2022, the most significant was the average region of group 2 (border with Ukraine). Following it in descending order are the average regions of group 4 (border with Kazakhstan), group 1 (border with Norway, Finland, Estonia, Latvia, Lithuania, and Poland), and group 3 (border with Abkhazia, Georgia, South Ossetia, and Azerbaijan). The list is closed by the average region of group 7, which borders the USA and Japan (*see Fig. 1*).

Judging by the 11 macroeconomic indicators considered, the border regions are economically less significant than the central (non-border) regions of the Russian Federation[11] (*Figures 2, 3*).

When ranking the border regions of the Russian Federation in descending order of average shares of the considered indicators, the top five in 2022 were: Krasnodar Krai, Rostov, Chelyabinsk, Novosibirsk, and Leningrad regions. The list is concluded by the Karachayevo-Chircassian, Republic, the Republics of Ingushetia, Tuva, and Altai, and the Chukotka Autonomous Okrug. These data slightly differ from those provided by analysts from the Russian Information Agency (RIA) (*Table 9*).

[11] Moscow and St. Petersburg are excluded from the list of central (non-border) subjects of the Russian Federation. The indicators of these cities and all other subjects of the Russian Federation differ significantly (are statistical outliers).

In both cases, the top five includes two subjects of the Russian Federation from group 4 and one each from groups 1, 2 and 3.

CONCLUSION

It appears that in the context of global hybrid wars, it is necessary to forecast various scenarios, promptly identify challenges, dangers, and threats, and respond accordingly. We must be prepared for various developments, consider all risks related to national security and defense, and have action plans to prevent the emergence of new aggressive entities at the borders. In the case of emergencies, urgent measures must be taken.

It seems that the above characteristics of the role of exports and imports for the Russian Federation could be useful in solving the strategic task of "forming a network of sustainable partnerships with foreign countries and creating the necessary infrastructure for foreign economic activity, technological and industrial cooperation, and exploring new markets". At the same time, the proactive development of the sectors identified as "locomotives" in the study will contribute to achieving national goals such as "a stable and dynamic economy" and "technological leadership".[12]

In the context of long-term sanctions, restrictions, and bans imposed on the Russian Federation, it is advisable to include a focus on the domestic market and markets of countries not hostile towards Russia in the strategy for the "locomotive" industries. It is important to note that the shown dependency of the "locomotive" sectors on export and import opportunities, as well as the volumes of exports and imports, illustrates the interconnection of elements within the economic system, which is determined by numerous factors.

For the successful development of the mining and metallurgy industries, as well as the production of computer, electronic, and optical equipment, it is not enough to invest solely in fixed assets — there must also be accessible external markets, the ability to conduct financial transactions without obstacles, the availability of qualified personnel, and many other factors. To reduce the share of imports in GDP, it is not only necessary to decrease their volumes but also to possess the necessary technologies, instruments, materials, software, and a substantial internal market to create production within the country. Similarly, inflation cannot be reduced by focusing on just one factor — the Central Bank's interest rate; birth rates cannot be increased by merely raising childbirth benefits; and corruption cannot be eradicated by only tightening penalties, and so on.

The country's economy is a complex system, and therefore, socio-economic, scientific-technological, and other tasks should be solved with consideration of both the direct and reverse connections between its elements and external conditions, involving many factors.

It is clear that in order to achieve the strategic goals of the country, coordinated participation of government bodies, businesses, and public organizations is essential. It also requires the alignment of strategic planning documents, state and regional programs and projects, as well as monitoring the implementation of decisions and the achievement of targeted indicators.

The information provided in this study about the economic importance of the border regions of our country can be utilized in addressing tasks set in the Fundamentals of the State Border Policy of the Russian Federation, as well as in organizing the protection of Russian territory from previously existing and newly identified threats during the special military operation.

[12] URL: http://www.kremlin.ru/events/president/news/73986

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Interrelations Between the Real and Financial Sectors of the Russian Economy in the Assessment of Russian Enterprises

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ABSTRACT

This article examines various aspects of the interaction between the financial sphere and the real sector of the Russian economy. The authors propose a classification of the functions of the monetary and financial system, describe key issues complicating the relationships between enterprises and financial institutions in modern Russia, and analyze several examples illustrating the ambiguous impact of macro-financial policies implemented by the Bank of Russia and the Ministry of Finance of the Russian Federation on economic development processes. Additionally, the study includes an analysis of numerical data obtained from surveys of Russian real-sector enterprises conducted from 1999 to 2024. The authors note that from 1999 to 2008, Russian macro-financial policy contributed to improving relations between the real sector and the financial sphere. However, this process was later stalled.

Keywords: financial sector; real sector; macro-financial policy; enterprise surveys; enterprises and banks; credit availability; tax burden

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The scale, content and quality of interaction between the industries producing goods and services of the real sector, as well as the monetary and financial system of the financial sector serving them is one of the key factors, which determines the dynamics of development of any national economy.

The main purpose of money and financial institutions is to simplify and lower the cost of interaction between the participants of economic processes. This thesis is present in different concepts in the works of the majority of theorists who studied the mechanisms of economic growth. For example, Adam Smith concluded, that money was the great wheel of circulation, the great instrument of exchange and commerce; the use of paper money instead of gold and silver money replaced an expensive instrument of exchange with a much cheaper and often equally convenient monetary mechanism [1].

Other classic scholars in economy provided similar points of view. In particular, J.-B. Say noted, that any society had a commodity, which everyone wanted to buy, not because of the usefulness it could bring in itself, but because of the easy way to exchange for other things necessary for consumption, meaning a commodity with the quantity easily proportional to the value of what one wanted to buy… This commodity is money [2]. J.S. Mill points out in his book published a little later, that in the public economy there is nothing more insignificant in its nature than money, that it is important only as an ingenious means of saving time and labour, as a mechanism for doing quickly and conveniently what would be done without it, though not so quickly and conveniently. [3]

Modern scholars contributed a more elaborated interpretation of the role of the monetary and financial system (financial sphere). R. Merton and Ts. Bodie itemise the following functions: movement of resources in time and space, as well as their accumulation and division of capital shares; risk management; settlements and payments; information support; solving psychological problems of incentives [4]. In turn, J. Stiglitz added to the above list as well the selection of investment projects and the enforcement of contracts, however, skipped the solution of psychological problems [5].

At the same time, the above-mentioned researchers have nearly missed the aspect of participation of public financial institutions in the processes of development of national economies. Such an approach, however, leaves a significant part of the financial sector outside the scope of analysis, moreover, the impact of the financial sector on economic processes has become very significant and can no longer be ignored. With very few exceptions, every national economy has a central bank as its main financial regulator. Ministries of Finance also plays an important role, being responsible for tax collection and distribution through the budgetary process. In many countries there operate large state-owned commercial banks, insurance companies, etc., and in the largest countries there are subordinate commercial institutions at the regional level.

In view of the abovementioned, we suggest the following list of functions of the monetary and financial system (financial sector) in the national economy:

- reducing transaction costs (by means of providing convenient and rapid payments);
- redistributing money from financially abundant to financially insufficient economic agents (by means of credit, taxation, budget spending, etc.);
- reducing risks (by increasing the safety of savings, redistributing risks among different financial institutions, etc.);
- accumulating monetary resources for major investment projects and building up reserves;
- transforming one type of financial resources into another (short-term into long-term; reserves into use, etc.);
- regulating macro- and microeconomic processes (by influencing the interest rate on loans and changing the reserve requirements for banks; by changing tax rates and using tax incentives; by means of budget expenditures, etc.);
- selecting investment projects;
- monitoring, financial control of compliance with contracts, counselling.

Hereby, the national monetary and financial system plays a supporting role in the economy by performing tasks of an intermediary nature. In this respect, the financial sector plays a secondary role if compared to the real sector, which produces goods and non-financial services and whose sustainable growth provides the resources needed for the expansion and development of economy. As to the financial sector, it can only generate these resources to a very limited extent (e.g. by increasing "credit leverage") and only as a supplement to resources received from the real sector.

Subsequently, the overall condition of the national financial sector cannot be better than that of the real sector in the medium and, even more so, in the long time period. If the real sector is in crisis, the financial system sooner, or later faces problems, so it is pointless to bail it out of the crisis by means of withdrawing money from the real sector.

Nevertheless, such events occurred from time to time. For example, in the 1990s, the Russian authorities tried to achieve financial stabilisation through a large-scale channeling of funds from the production sectors into the banking sector and the capital market. This was done by means of non-payment of money for the work of workers and employees by domestic enterprises under state orders; failure to fulfil budgetary obligations to social institutions and workers, the army, pensioners, etc.; transfer of huge interest to Russian and foreign financial investors for the purchase of government securities. For example, in July 1998, the yield on short-term government bonds (GKOs) reached 58 per cent a year.[1] Thus, the Govermnent managed reduce temporarily nominal inflation rates and stabilise the ruble exchange rate for a while. However, by mid-1998, the resources for channeling from the real sector to the financial sector have exhausted.

The logical outcome of such a policy was the deep crisis of August 1998, when the government was forced to officially announce the cessation of payments on public debt and support for the ruble exchange rate, which collapsed it from Rb 6 to Rb 16/USD within just a single month.[2] In addition, according to the results of 1998, the GDP of the Russian Federation plummeted by 5.3 per cent.[3] Thus, the events of 1998 have become a clear illustration of the thesis, that the policy of financial stabilisation, which ignores the problems of the real sector, is not able to resolve the existing contradictions and ultimately leads to financial crisis.

At the same time, one should remember that problems are inevitable in the activity between the financial and real sectors of the economy. The objective interests of financial institutions and real sector firms are often divergent, even despite the fact, that economic growth is equally beneficial for them. While all companies of the real sector strive to minimise their own transaction costs related to financial operations, financial institutions seek to increase their go-between rent.

Mechanisms of market competition allow finding a mutually acceptable balance of interests. If the market has a sufficient quantity of banks and other institutions capable to provide high-quality intermediary services, the financial sector actively runs competition for production companies, which objectively reduces transaction costs of the latter.

At the same time, monopolistic dominance situations often occur in the financial spheres of various countries, including Russia. This happen when an insufficient number of institutions operate in these segments or when cartel agreements take place. As a rule, such phenomena of monopolism lead to growing transaction costs for companies in the real sector.

The antimonopoly intervention of the State is extremely desirable in such situation. The State, as an arbitrator, should ensure a reasonable balance of interests of both parties: after all, if the quality of interaction is at a high level and no serious mutual claims exist between them this will definitely contribute to growing rate of domestic socio-economic development.

However, it is not easy to obtain reliable assessments of the nature and quality of relations

[1] URL: https://cbr.ru/statistics/b_sector/interest_rates_98/

[2] URL: https://cbr.ru/statistics/b_sector/interest_rates_98/

[3] URL: https://cbr.ru/statistics/b_sector/interest_rates_98/

between the financial sphere and the real sector. Macro-financial statistical data allows collecting quantitative estimation of interaction between these two sectors. The following indicators employed for this, are the following, namely:, the coefficient of monetisation of the economy (the ratio of money supply to GDP), the dynamics of lending in the country as a whole and separately in various sectors of the economy, the structure of loans in accordance with repayment terms, etc.

The analysis of macro-financial statistics allows identify important objective laws, which one needs to take into account when developing and implementing various measures of state economic policy. For example, many experts note that the current level of monetisation of the Russian economy is notably lower than in the vast majority of developed countries. In particular, in the timeframe period after 2020, the monetisation rate in Russia was between 50 and 56 per cent, while in the USA it was over 90, in Germany — 100, in France and the UK — 130, and in Japan and China — 200 per cent [6]. As Y.M. Mirkin points out, such an indicator of monetary security in 2020 positions our country in the 69th place of the global list in terms of monetisation of the economy and in the 66th place in terms of credit saturation [7]. This situation involves a theoretical possibility of intensifying the processes of domestic socio-economic development by boosting the level of monetisation and, consequently, the availability of financial resources for real sector enterprises. At the same time, the growing the level of monetisation of the Russian economy will definitely result into the desired effects only if the national financial sphere indicates a fundamentally higher level of development through its diversification and complexity, as well as the quality of institutions providing financial transactions is significantly improved.

The direct responsibility of the State authorities is to ensure diversification of the financial sphere, expand the range of institutions and mechanisms of monetary support of the real sector, the variability and flexibility of the instruments of monetary regulation. Unfortunately, until recently the financial and economic bloc represented by the Bank of Russia, the Ministry of Finance and other agencies did not pay considerable attention to accomplishing this mission [8–11]. Besides, although the Bank of Russia declares its intention to take various measures in the new versions of official documents related to its monetary policy,[4] it is still unclear the extent to which these promises will be a reality.

At the same time, analyses of quantitative indicators of macro-financial statistics gives almost no clue, when it comes to assessing the qualitative features of interaction between the financial sphere and the real sector of the economy. In these circumstances, questionnaire surveys of enterprises partially contributes to cover this information gap. Despite their subjectivity, the evaluative judgements stated by representatives of the real sector actually describe well enough the peculiarities of their relations with banks, tax authorities, etc.

Since 1999, the Institute of National Economic Forecasting of the Russian Academy of Sciences has been conducting such surveys on a regular basis. During this timeframe period, a lot of information has been collected on various aspects of domestic business operation of enterprises, including the latter interaction with the Russian financial sphere [12, 13].

The key factor here is the collaboration of goods-producing enterprises with banks: the analysis of the responses obtained over the past 25 years indicates that it has generally been quite satisfactory over this period of timeframe, although, sometime, there have been registered certain problems.

In the early 2000s, the situation improved rapidly according to the respondents. From 2001 to 2003, almost half of the respondents reported that banks were more ready to accomplish their commitments to client companies. Apparently, this progress in relations occurred due to a strong recovery growth of the Russian economy to follow up after a deep and prolonged transformation crisis of the 1990s. Then, the process of relationship building paused to a halt somewhat, but then moved on further. However, as the result of the crisis, in 2009 the share of

[4] URL: https://cbr.ru/content/document/file/150582/on_2024(2025–2026).pdf; https://cbr.ru/about_br/publ/ondkp/on_2025_2027

Table 1

Response to survey question: "In your opinion, how have banks fulfilled their obligations to enterprises over the past year?" (Total responses = 100 per cent)

Time / Response	Better	The same way	Poorly
June-August 2001	54.3	38.7	7.0
June-August 2001	48.5	47.3	4.2
June-July 2003	49.4	48.9	1.7
August-September 2004	27.3	67.1	5.6
July-August 2005	30.4	66.3	3.3
August-September 2006	34.6	65.4	0.0
August-September 2007	26.7	70.0	3.3
August-September 2008	21.7	72.7	5.6
April-May 2009	3.8	60.6	35.6
September-October 2009	3.9	75.2	20.9
August-September 2010	20.7	72.3	7.0
March-April 2011	12.0	82.0	6.0
October-December 2011	14.2	78.7	7.1
November-December 2012	13.4	78.1	8.5
November-December 2013	10.4	80.3	9.3
November-December 2014	6.4	78.1	15.5
November-December 2015	3.4	77.0	19.6
November-December 2016	6.3	78.0	15.7
November-December 2017	10.3	76.3	13.4
November-December 2018	13.5	78.7	7.8
November-December 2019	13.3	79.4	7.3
November-December 2020	9.6	80.8	9.6
November-December 2021	10.1	79.2	10.7
November-December 2022	8.1	75.0	16.9
November-December 2023	9.8	77.9	12.3
November-December 2024	7.4	71.8	20.8

Source: compiled by the authors.

complaints of deteriorating client's policy of banks' increased manifold, while positive assessments became very rare. For the next four years, the situation has not changed: the vast majority of respondents reported that their relationship with banks indicated no positive progress.

In the timeframe period of 2014–2016, the subsequent deterioration of interaction between the

Table 2

Response to survey question: "Has your enterprise faced intentional delays in bank payment processing over the past year?" (Total responses = 100 per cent)

Time / Response	Positive	Negative	Not sure
June-August 2001	18.9	52.4	28.6
June-August 2002	7.6	64.3	28.1
June-July 2003	10.7	70.2	19.1
August-September 2004	11.1	74.2	14.7
July-August 2005	9.7	74.1	16.2
August-September 2006	7.4	75.8	16.8
August-September 2007	10.6	78.2	11.2
August-September 2008	9.4	69.2	21.4
April-May 2009	15.6	63.0	21.4
September-October 2009	8.9	72.2	18.9
February-March 2010	11.8	74.0	14.2
August-September 2010	7.6	76.4	16.0
March-April 2011	7.0	76.5	16.5
October-December2011	4.5	71.6	23.9
April-May 2012	9.1	74.1	16.8
November-December 2012	4.8	77.1	18.1
November-December 2013	5.2	76.8	18.0
November-December 2014	5.7	78.7	15.6
November-December 2015	11.2	75.3	13.5
November-December 2016	5.6	76.3	18.1
November-December 2017	7.7	76.2	16.1
November-December 2018	7.1	79.6	13.3
November-December 2019	9.0	79.5	11.5
November-December 2020	5.1	84.8	10.1
November-December 2021	4.7	83.9	11.4
November-December 2022	7.9	73.8	18.3
November-December 2023	7.2	75.2	17.6
November-December 2024	16.7	68.7	14.6

Source: compiled by the authors.

enterprises and banks occurred, when the Russian economy was recovering the consequences of a not at all successful transition to a Ruble's floating exchange rate. During this period, between 15 and 20 per cent of respondents experienced more problems dealing with banks. Later, the situation has become more sustainable, however, in 2022, after the introduction of sanctions, and in 2024, after a sharp increase in the key rate, the share of complaints reached 17–20 per cent once again. However, it is worth noting, that over the past 15 years, the vast majority of respondents (70 to 80 per cent) believed that banks fulfilled their obligations traditionally at the same level (*Table 1*). In other words, there has been no dramatic deterioration of relations over this period.

A similar, although a smoother dynamic was visualised within the framework of analyses of the responses to the question about banks which deliberately delayed payments. This problem was extremely dramatic until 1999, but later the situation has changed. After 2003, the proportion of enterprises, which did not have this problem, remained stable at around 70–80 per cent. Later, due to the economic shocks of 2008, 2014 and 2024, the proportion increased again. In particular, in 2024, the ratio of such unhappy respondents reached 17 per cent, which is a level previously observed only in 2001 (*Table 2*). In our view, this is quite an alarming reality.

It is worth noting, that such surveys help a lot to understand the real availability of bank loans to Russian enterprises. However, regretfully, there has been no progress in this area since 2003. Moreover, since 2014 the situation with the availability of credits to the real sector has become significantly worse in comparison to the years of the 2000s.

In 2003, for example, the share of enterprises whose cooperation with banks was limited to cash and payment services was only 14.8 per cent. At the same time, the share of those entities, which borrowed for working capital was 57.2 per cent and for investment projects of different duration was 28 per cent. By 2024, the share of the first category grew to 53.7 per cent, meanwhile the share of the second category dropped to 26.9% and the share of the third category decreased to 19.4 per cent (*Table 3*).

In general, the situation can hardly be described as normal, if no more than 20 per cent of companies had a real access to investment bank loans for 10 years, even if they had experienced contradictions with the banks.

For example, the given surveys indicate that the best cooperation activities between Russian banks and the real sector companies were in the timeframe period between 2001 and mid-2008. Then the process slowed down and the availability of credit loans decreased. Such a phenomenon has raised many questions about the quality of macro-financial policy in the recent years.

In this context, it is not surprising that domestic enterprises generally were very skeptical about the high key rate policy introduced by the Bank of Russia in 2023. At the end of 2024, 68.9 per cent of our respondents considered that such consequences would be "rather negative" or "definitely negative" for the Russian economy, while only 5.4 per cent believed that they would be "definitely positive" or "rather positive" (*Table 4*). This divergence of opinions means that the Bank of Russia, either at best, explains very incompetently the significance of its interest rate policy to representatives of the real sector, or, at worst, makes wrong decisions causing significant damage to our country's economic development.

One of the important elements of interaction between the financial and real sectors is the taxation system of companies, which, of course, generally causes a lack of enthusiasm among companies. This issue very often raises debates regarding the gravest business activity problems for Russian companies. The share of those who are worried about the high level of taxation fluctuated between 2001 and 2024, but never exceeded the range of 33–58 per cent [13]. Besides, many believed that the level of the real tax burden was constantly increasing (*Table 5*).

Such opinions should be regarded with a good deal of consideration, even if they are even partially correspond to reality.

Definitely, the growth of the real tax burden for many years is utmost impossible: because the critical point may come quite quickly followed by

Table 3

Response to survey question: "What does your enterprise's cooperation with Russian banks currently involve?" (Total responses = 100 per cent)

Time / Response	Cooperation limited to cash and settlement services only	Payment services and working capital loans	Cash and settlement services, working capital loans for investment projects of 1–2-year duration	Cash and settlement services, working capital loans for investment projects of 3–5-year or more duration
June-August 2001	28.1	57.3	11.0	1.6
June-August 2002	26.6	60.7	11.0	1.7
June-July 2003	14.8	57.2	17.0	11.0
August-September 2004	26.1	50.3	19.1	4.5
June-August 2005	26.0	44.8	22.1	7.2
August-September 2006	29.2	46.0	14.3	10.5
August-September 2007	35.2	35.1	19.6	10.1
August-September 2008	31.4	42.0	13.0	13.6
April-May 2009	40.4	36.2	10.1	13.3
September-October 2009	47.8	35.9	6.0	10.3
August-September 2010	40.4	35.6	9.9	14.1
March-April 2011	39.2	34.6	11.1	15.1
October-December 2011	43.7	30.5	13.9	11.9
April-May 2012	43.6	32.0	12.2	12.2
November-December 2012	41.6	33.0	11.5	13.9
November-December 2013	50.6	27.8	9.1	12.5
November-December 2014	41.5	34.0	10.9	13.6
November-December 2015	47.8	33.1	6.2	12.9
November-December 2016	50.9	31.5	6.9	10.7
November-December 2017	51.6	27.7	6.5	14.2
November-December 2018	52.5	34.0	2.1	11.4
November-December 2019	46.4	35.5	4.2	13.9
November-December 2020	47.1	32.6	6.5	13.8
November-December 2021	54.4	27.9	6.1	11.6
November-December 2022	45.6	34.4	5.6	14.4
November-December 2023	62.1	19.4	5.6	12.9
November-December 2023	53.7	26.9	6.0	13.4

Source: compiled by the authors.

Table 4

Response to survey question: "In your opinion, what's the impact of the current high key interest rate policy of the Bank of Russia on the Russian economy?" (Total responses = 100 per cent)

Time / Response	Definitely positive	Rather positive	50–50 positive and negative	Rather negative	Definitely negative
November 2024	0.7	4.7	25.7	35.1	33.8

Source: compiled by the authors.

Table 5

Response to Question: "How do you assess changes in the actual tax burden on your enterprise over the past 2–3 years?" (Total responses = 100%)

Time / Response	The tax burden has noticeably increased	The tax burden has increased, but not significantly	The tax burden has not practically changed within the last 2–3 years	The tax burden has decreased, but not significantly	The tax burden has diminished noticeably
November-December 2012	33.5	41.2	21.7	2.4	1.2
November-December 2015	23.2	41.1	33.3	2.4	0.0
November-December 2018	24.8	44.7	30.5	0.0	0.0
November-December 2021	25.2	41.5	31.3	2.0	0.0
November-December 2024	26.0	39.0	30.2	1.4	3.4

Source: compiled by the authors.

Table 6

Response to Question: "In your opinion, how has tax evasion among enterprises evolved in the Russian economy over the past 2–3 years?" (Total responses = 100%)

Time / Response	Tax evasion has decreased	Tax evasion is almost the same level as it was 2–3 years ago	Tax evasion has increased	Not sure
February-March 2007	43.8	26.1	3.9	26.2
November-December 2012	10.2	30.5	14.4	44.9
November-December 2015	14.0	19.7	14.0	52.3
November-December 2018	20.7	22.9	11.4	45.0
November-December 2021	27.4	18.5	7.5	46.6
November-December 2024	29.9	17.0	7.5	45.6

Source: compiled by the authors.

Table 7

Response to Question: "How important is the ruble-to-US dollar exchange rate for your enterprise?" (Total responses = 100%)

Time / Response	Null value	Scarce	Medium	Grand
April-May 2012	20.6	37.0	26.0	16.4
November-December 2013	21.9	36.0	24.7	17.4
April-May 2015	7.7	20.7	29.7	41.9
November-December 2016	17.2	22.7	30.1	30.0
April-May 2018	9.7	26.1	35.1	29.1
November-December 2019	16.5	28.0	29.9	25.6
April-May 2021	12.8	18.8	36.2	32.2
November-December 2022	9.8	25.0	39.4	25.8
November-December 2023	12.0	20.8	35.2	32.0
November-December 2024	11.3	24.7	41.3	22.7

Source: compiled by the authors.

Table 8

Response to Question: "How important is the ruble-to-euro exchange rate for your enterprise?" (Total responses = 100%)

Time / Response	Null value	Scarce	Medium	Grand
April-May 2012	19.7	35.4	27.9	17.0
November-December 2013	23.6	38.8	23.0	14.6
April-May 2012	18.1	21.3	30.3	30.3
November-December 2016	15.2	27.2	31.5	26.1
April-May 2012	9.7	34.4	31.3	24.6
November-December 2019	23.6	30.9	28.5	17.0
April-May 2021	12.7	22.8	30.9	33.6
November-December 2022	15.9	29.5	37.9	16.7
November-December 2023	20.0	22.4	35.2	22.4
November-December 2024	18.7	28.7	35.3	17.3

Source: compiled by the authors.

a galloping increase in bankruptcies and a collapse of production. Besides, macroeconomic statistics do not reflect a strong inflow of tax revenues into the consolidated state budget. In particular, from 2017 to 2023, the size of state budget revenues in relation to GDP will increase from 33.7 to only 34 per cent.[5]

At the same time, the tightening control by means of digitalisation of the tax sphere and stricter enforcement policy contribute to growing tax revenues, especially in the segment of small and medium-business enterprises. In addition, according to Rosstat, between 2017 and 2022, the share of the state budget financed by domestic taxes increased from 62.1 to 79.3 per cent. Thus, the tax burden on Russian companies has increased to some extent.

[5] URL: https://www.fedstat.ru/indicator/58404

Besides, it is worth noting, that while in the past Russian companies were able to adjust to the increasing nominal tax burden by evading taxes, in recent years, their tax payment attitude has become more loyal (*Table 6*) which also means, that it is now more difficult for Russian companies to find ways to reduce the real tax burden.

In such a scenario, the Russian fiscal authorities have to be very considerate to maintain the tax policy within reasonable limits, so that it would not turn into a hindrance to further growth of the domestic economy. In view of the abovementioned, the increase in the corporate tax rate from 20 to 25 per cent from 2025, which coincided with the key rate rise, is a highly questionable measure. Actually, this was like a double punch for domestic real sector companies. This abnormal situation could potentially provoke an internal economic shock. Probably, the future measures, which may affect the businesses of domestic companies should be separately introduced over time to ensure smoother and more predictable changes in the national economy.

Another extremely important instrument of the financial system able to make a strong impact on the activities of enterprises in the real sector of the economy is the dynamics of the national currency exchange rate. Over the past 10–12 years, this area has also been through a rather contradictory chain of events. For example, the practical relevance of the ruble's exchange rate against the US dollar and the euro for Russian enterprises diminished in the periods of stability and increased in the times of crisis, such as in 2015 (*Table 7–8*). At the same time, the key factors, that determine the relevance of the ruble exchange rate for domestic enterprises were always a considerable share of imports in the purchase of raw materials and components, as well as a high need for imported machinery and equipment. Competition and export issues also play a noticeable role, but to quite a smaller extent (*Table 9*).

Table 9

Response to Question: "What factors determine the importance of the ruble exchange rate to the dollar and euro for you?" (Total responses >100%)

Time / Response	A notable share of exports in product sales	A notable share of imports in the purchase of raw materials and components	High demand in the purchase imported machines and equipment	High level of competition with foreign producers in the Russian markets	High level of competition with foreign producers in the markets beyond Russia
March-April 2008	35.2	44.0	47.3	19.8	4.4
August-September 2010	27.6	54.6	42.8	21.7	3.3
April-May 2012	18.2	53.7	42.2	24.0	5.8
November-December 2013	15.6	55.5	43.8	20.3	3.9
April-May 2015	17.0	69.6	34.8	28.9	5.2
November-December 2016	15.6	60.7	43.7	17.0	4.4
April-May 2018	19.4	67.7	49.2	16.9	4.8
November-December 2019	17.5	61.3	48.9	14.6	7.3
April-May 2021	20.0	54.6	52.3	17.7	11.5
November-December 2022	20.2	56.3	42.9	21.0	5.0

Source: compiled by the authors.

It is worth noting, in particular, that the data obtained from our surveys may cast doubt on the concept that, all other things being equal, the weakening of the Ruble exchange rate is beneficial for the Russian economy [14]. Over the course of the survey, the number of respondents, who supported strengthening or stability of the Ruble exchange rate, has always been much higher than the number of respondents, were advocates for a weakening of the Ruble exchange rate. By the end of 2024, the share of the second category plummeted to the minimum level of 4.7 per cent for the entire observation period (*Table 10*).

It seems to us, that one should take into account as well the points of view of representatives of the real sector for the process of formulating the Ruble exchange rate policy: too weak and volatile exchange rate does not satisfy the overwhelming majority of Russian enterprises, since it leads to a very significant economic unpredictability.

CONCLUSIONS

The research conducted allowed us to draw the following conclusions:

1. The quality and nature of the relationship between the financial sphere and the real sector have always been and traditionally remain one of the key factors, which determines the dynamics of the development of any national economy.

2. The financial sphere, which mainly performs intermediary functions, is still playing a secondary role compared to the real sector, in the long run, its condition cannot be better than that of the real sector. In this respect, it is pointless to solve the problems of the financial sector at the expense of the resources of the real sector.

3. The analysis of macro-financial statistics allows making an indirect assessment of the quantitative impact of monetary trends of developments on the processes of economic activity. However, it does not provide a clear information on the quality of the interaction between the financial and real sectors of the economy.

Table 10

Response to Question: "Which foreign exchange market developments are currently the most favorable for your enterprise?" (Total responses = 100%)

Time / Response	Weakening of the Ruble exchange rate	Stability of the Ruble exchange rate	Strengthening of the Ruble exchange rate	Fluctuations of the Ruble exchange rate make no difference for me
April-May 2014	14.9	44.1	26.7	14.3
April-May 2016	13.1	38.5	36.6	11.8
November-December 2016	8.9	44.9	38.0	8.2
April-May 2017	14.4	42.5	28.8	14.4
April-May 2018	9.4	54.7	33.6	2.3
November-December 2019	10.6	44.7	31.7	13.0
April-May 2021	8.2	38.3	48.0	5.5
November-December 2022	15.1	54.8	22.2	7.9
November-December 2023	8.1	43.5	42.7	5.6
November-December 2024	4.7	44.6	41.2	9.5

Source: compiled by the authors.

4. Regular business surveys contribute to fill the gap in knowledge to some extent about the relationship between the financial and real sectors.

5. The analysis of the results of the questionnaire surveys has revealed a number of problematic issues:

- Relations between Russian enterprises and banks improved noticeably in 2001-2008, but later such positive dynamics stopped for a long time.
- For over two decades, the Russian financial authorities have been unable to solve the problem of increasing the availability of credit to real sector enterprises. Moreover, after the year of 2014, the share of those who have access to loans from investment banks diminished to less than 20 per cent.
- The overwhelming majority of domestic companies does not trust the feasibility of the policy of a high key rate.
- The tax burden on the real sector is gradually growing, and the opportunities are shrinking to adjust to it by means of tax evasion. Perhaps the Russian financial authorities should take a closer look at the feasibility of further increase of the key interest rate.
- Nowadays, representatives of the overwhelming majority of domestic companies stand out for stabilising or strengthening the ruble exchange rate.

6. The results of the survey indicate that there are serious differences of opinion between the Russian real sector and the federal financial authorities. This situation is undesirable. Therefore, it is necessary to consider more closely the opinions and arguments of domestic enterprises in the formulation of Russia's macroeconomic and macro-financial policy.

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Econometric Analysis for Russia-Iran Foreign Trade Relations

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ABSTRACT

The aim of the study is to examine the prospects for economic relations between Russia and Iran in the context of the latter's transition to free trade within the EAEU. **The relevance** of the article stems from the growing importance of international trade in the context of globalisation and the need to develop effective strategies for trade. According to the author, due to geopolitical instability and economic sanctions, the study of factors affecting foreign trade is particularly important for sustainable economic growth and diversification of export markets. **Methods.** The research uses descriptive statistics and econometric analysis including the gravity approach. **Results.** The econometric models in the article allow to confirm a strong potential for rapidly growing trade between Russia and Iran as a result of such an agreement sealed. The author also draws conclusions on the importance of efforts to promote economic integration and shows the need for further measures to develop the system of bilateral free trade agreements.

Keywords: foreign trade; Russia; Iran; globalisation; economic integration; bilateral agreements; free trade; gravity model; regression analysis

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INTRODUCTION

In the current geopolitical context, the integration of the economies of various countries has gained particular importance, especially in the Eurasian space, where new regional unions are being formed. For example, the EAEU and Iran are striving to create a free trade area (FTA). Russia, as the leader of the integration process within the Eurasian Economic Union, actively collaborates with Iran. In recent years, both countries have strengthened bilateral relations, driven by mutual economic interests and the necessity to adapt to new challenges in the international arena.

The EAEU and Iran, possessing a rich resource base, strategic geographic position, and significant economic potential, demonstrate mutual interest in developing cooperation.

The prospects of Iran's integration into the EAEU are the subject of numerous studies, as such cooperation could significantly alter the ecomic landscape of the region. However, these studies are mainly qualitative in nature and do not provide quantitative assessments of the potential impact of integration on the economic indicators of the parties involved.

In this regard, there is a need to apply econometric methods for modeling and forecasting the consequences of Iran's potential accession to the EAEU. The results obtained are expected to be useful for government bodies, the business community, and academic circles. The econometric model developed within this work can serve as a tool for making strategic decisions and planning further cooperation, contributing to the enhancement of the region's economic stability and competitiveness.

METHODOLOGY

Gravitational models, widely used in econometrics for analyzing international trade, allow for the examination of the statistical relationship between various factors. The history of these models traces back to the work of economist Jan Tinbergen, who proposed a concept similar to the one presented in the 1960s. He noted that the volume of trade between two countries is usually proportional to their economic size and inversely proportional to trade costs [1].

The gravitational approach to modeling international trade has evolved over time. The modern formulation of the gravitational model was developed in the 1970s through the work of economists such as Jan Tinbergen, James Anderson, and Eric Van Wincoop [2, 3]. They applied mathematical tools, similar to the laws of gravity, to analyze trade between countries [4], based on the following assumptions:

- Trade is proportional to the economic size of the country: Larger economies produce more goods and services for export, and they have higher levels of domestic consumption.
- Trade is proportional to the distance between the economic centers of the trading countries: The farther apart two countries are, the less likely they are to trade with each other due to high transport and other trade costs.
- Economic integration stimulates trade growth. The model can account for different forms of economic integration (such as customs unions or free trade areas), which help reduce trade costs between countries.
- The model can be supplemented with various coefficients to account for other factors affecting trade, such as linguistic, cultural, and historical ties between countries. Modern gravitational models often include additional dummy variables reflecting institutional characteristics, trade barriers, production structure, infrastructure, etc.

Gravitational models are widely used to analyze trade flows, assess and predict the consequences of changes in trade policy, and evaluate the impact of economic events on the global economy. This approach has gained significant popularity due to the high predictive power of the models and the availability of data and methods for estimating coefficients.

Models of this type also allow for the assessment of trade potential between countries — the maximum possible trade volume under ideal con-

ditions (without any barriers or restrictions) — based on their economic, geographic, institutional, and cultural characteristics. Even if it is not possible to establish precise numerical values, it is possible to roughly estimate how much of the potential is realized and identify growth areas that are most effective for strengthening trade relations.

RESULTS AND DISCUSSIONS

The Eurasian Economic Union was established in 2015. It consists of five countries: Russia, Belarus, Kazakhstan, Armenia, and Kyrgyzstan. The goal of the organization is to ensure the free movement of goods, services, capital, and labor between the member states. A single customs space ensures the absence of customs duties on the internal border and a unified customs tariff on the external border. Within the framework of the EEU, coordination of economic policy, harmonization of technical regulation requirements, sanitary, veterinary, and phytosanitary measures is carried out; integration institutions and supranational governing bodies, such as the Eurasian Economic Commission (EEC), have been created. Russia, as the largest economy of the EEU, plays a key role in shaping the Union's policy and promoting integration processes [5].

Trade relations between the Eurasian Economic Union and the Islamic Republic of Iran are of strategic importance to both. Geographical proximity, the need to diversify markets and sources of supply, as well as the desire to minimize the impact of international sanctions, are driving both parties to deepen cooperation.

According to the EEC, in 2022, the total trade turnover between the EEU and Iran amounted to 5.6 billion US dollars, demonstrating a positive growth trend.[1] Exports from the EEU to Iran mainly consist of food products and agricultural goods (grain, oil, meat), as well as products from the chemical industry, metals and metal products, machinery, equipment, and vehicles. Imports from Iran to the EEU are mostly represented by agricultural products (fruits, dried fruits, and vegetables) and petrochemical industry products.[2]

Russia is the main trading partner of Iran among the countries of the Union, accounting for more than 70% of the total trade turnover. Mutual interest is reflected in the expansion of the range of goods and an increase in trade volumes.

In May 2018, a Temporary Agreement leading to the creation of a Free Trade Area (FTA) between the EEU and Iran was signed in Astana. It came into effect in October 2019 and became the first step toward creating a full-fledged free trade area.[3] Its main provisions include reducing or eliminating import duties on a specific list of goods (primarily agricultural products), harmonizing rules of origin, and creating a joint committee to monitor the implementation of the agreement.

The implementation of this document led to a growth in trade turnover of more than 30% [6]. The Temporary Agreement demonstrated the mutual interest of the parties in strengthening economic ties and laid the foundation for further cooperation.

Thus, negotiations began for the conclusion of a full Free Trade Agreement. It envisages extending the free trade regime to a larger portion of the product range, as well as specifying a dispute resolution mechanism and the procedure for adopting protective measures. The document is expected to be an important step in the development of trade and economic relations between the participating countries. At the same time, Russia plays a key role in promoting Iran's integration into the EEU, acting as the main initiator and moderator of negotiations, as well as the primary beneficiary of this process.

The Temporary Agreement has already proven its effectiveness by establishing the foundations for sustainable cooperation. The conclusion of a

[1] URL: https://eec.eaeunion.org/news/speech/zal-vyzhidaniya-v-evraziyskoy-komissii-privetstvuyut-namerenie-irana-stat-nablyudatelem-pri-eaes/

[2] URL: https://eec.eaeunion.org/upload/medialibrary/57a/EAES_Iran.pdf

[3] URL: https://eec.eaeunion.org/upload/medialibrary/77b/FTA-EAEU_Iran.pdf

full Free Trade Agreement will strengthen the positions of the EEU and Iran on the international stage, contributing to the increased competitiveness of the economies and the well-being of their populations. However, to understand the further prospects, it is necessary to conduct economic research using quantitative methods.

One of the methods for assessing and forecasting the potential of foreign trade between Russia and Iran, as well as other countries, is a multifactor econometric model. Its advantage is that it allows identifying factors specific to Russia that influence foreign trade, while its drawback is that the number of observations is limited by the number of countries trading with Iran for which relevant statistical data is available.

The model is presented in a logarithmic form and has the following structure:

$$\left(\ln Y = \beta_0 + X_1 \ln \beta_1 + X_2 \ln \beta_2 + \ldots + X_n \ln \beta_n + \varepsilon\right), (1)$$

where ε is the random error; $X_1 - X_n$ are the values of the independent variables considered; $\beta_1 - \beta_n$ are the regression coefficients.

The independent (forecasted) variable in this model is the trade turnover of Iran (Y) with

Table 1

Coefficients of econometric model and regression statistics

Parameter	Coefficient	Standard errow	*t*-statistics	*p*-value
Y-intersection	14.26161	2.663713	5.354035	3.74E-07
ln(GDP_j)	1.121109	0.104479	10.73047	1.15E-19
COM.B	2.605968	0.80102	3.253311	0.001451
ln(POP_j)	–1.13516	0.316894	–3.58214	0.000479
ln($DIST_{ij}$)	2.193679	0.720813	3.043338	0.002828
FTA.PTA	1.066041	0.468479	2.275538	0.024497
Regression statistics				
Multiple *R*	0.759321313			
R-squared	0.576568856			
Normalized *R*-squared	0.560407362			
Standard errow	2.266625953			
Observations	137			
Variance analyses				
	F	Significance F		
Regression	35.67546751	6.5427E-23		

Source: compiled by the author.

a partner country in millions of US dollars at nominal values in 2022 prices.

The model considers the impact of the following factors:

- GDP_j — GDP of the partner country in foreign trade in 2022 at fixed prices of 2015, in trillion dollars;
- COM.B — sharing common borders;
- POP_j — population of the partner country in foreign trade;
- $DIST_{ij}$ — distance between the economic centers of the two countries;

FTA.PTA — participation of the two countries in a Free Trade Agreement (FTA) or Preferential Trade Agreement (PTA), a binary qualitative variable that takes the value of "1" for a pair of countries that are members of a trade union and "0" for countries not part of the trade agreement.

The model was estimated based on 160 observations in logarithmic form; the coefficients and regression statistics are presented in *Table 1*.

Thus, the equation of the model is as follows:

$$\ln \text{VOL} = 14,262 + 1,121 \ln \text{GDP}_j - 1,135 \ln \text{POP}_j + \\ + 2,194 \ln \text{DIST}_{ij} + 1,066 \text{FTA.PTA} + 2,606 \text{COMB}. \quad (2)$$

The conclusions from the regression statistics indicate that the model is overall significant. The multiple correlation coefficient (R) is 0.759, which suggests that about 76% of the variation in the dependent variable is explained by the regressors considered.

The coefficient of determination R squared = = 0.5766, meaning that approximately 58% of the variance of the dependent variable is explained by the model. The F-statistics for the regression is 35.68, which indicates statistical significance for the model as a whole.

The p-values and t-statistics indicate the statistical significance of all the regression coefficients.

Therefore, we can conclude that there is a strong positive relationship between the volume of trade and the following factors:

- sharing a common border, which helps reduce transport and logistics costs and simplifies business contacts;
- distance between economic centers, which is proportional to the logistics costs imposed on participants in international trade, directly affecting the competitiveness of most export goods;
- membership in a bilateral or multilateral free trade agreement, emphasizing the importance of removing tariff and non-tariff barriers and other costs to develop international trade and economic cooperation.

The regression coefficients allow not only qualitative conclusions but also provide a quantitative assessment of the impact of the studied factors on trade. The most significant interest lies in the coefficient of the variable participation in trade agreements and free trade zones (FTA.PTA). Given that the model is log-linear and the FTA.PTA variable is binary, the interpretation of this coefficient requires the following formula:

$$R = (e^{\beta_n} - 1) * 100\%, \quad (3)$$

where R represents the percentage change in Y when the value of the dummy variable changes from "0" to "1"; β_n is the coefficient of variable n.

Calculations based on this formula allow us to conclude that, in the case of Iran, participation in a trade agreement or a free trade zone (FTA) could lead to nearly a two-fold increase in trade volumes (190%).

Based on the results obtained, several key conclusions can be made, and corresponding solutions proposed.

Firstly, to further increase trade volumes between Iran and Russia, attention should be focused on improving transport and logistics infrastructure. Investments in the development of transport corridors, modernization of ports, and the creation of new logistics centers will contribute to significant reductions in costs and improve the competitiveness of exported goods.

Secondly, to remove trade barriers and create favorable conditions for business, a crucial step

is to intensify efforts to conclude a Free Trade Agreement (FTA) between the EAEU and Iran. This will help reduce tariff and non-tariff barriers, simplify administrative procedures, and enhance the transparency of trade operations. The currently active Temporary Agreement has proven to be an effective measure for the development of bilateral trade in agricultural products. The Permanent Agreement is awaiting ratification. Its conclusion could lead to a substantial strengthening of economic ties between the countries and provide them with additional opportunities to expand markets and attract investment.

The second type of model is characterized by the fact that the dependent variable is the export of each country in the sample. However, since the export of one country is the import for another, the model also accounts for trade turnover. The data set includes exports of countries to their trading partners for which statistical data is available, and whose trade turnover is not zero. The advantage of this model is the significantly larger number of observations, allowing for the evaluation of a broader set of factors. At the same time, it is less effective than the previously described model in identifying the statistical significance of specific factors for any single country, and only allows for generalized conclusions — i.e., its findings are not universally applicable.

The model is as follows:

$$\ln Y = \beta_0 + \ln \beta_1 + \ln \beta_2 + \ldots + \ln \beta_n + \varepsilon, \quad (4)$$

where ε is the random error; $\beta_1 - \beta_n$ are the regression coefficients.

It is calculated using panel data on exports, GDP, population, and other parameters from

Table 2

Variable models

Y	ln_EXPORT	Dependent variable, volume of exports from country i to country j, in thousand USD.
β_1	ln_GDP_X	GDP of exporting country in USD at 2015 prices, trillion USD
β_2	ln_GDP_I	GDP of importing country in USD at 2015 prices, trillion USD
β_3	ln_POP_X	Population of exporting country, in millions people
β_4	ln_POP_I	Population of importing country, in millions people
β_5	ln_DIST	Distance between economic centers of exporting and importing countries (km)
Dummy variables		
β_6	EU	Dummy variable, equals “1” if both countries are EU members
β_7	EAEU	Dummy variable, equals “1” if both countries are EAEU members
β_8	ASEAN	Dummy variable, equals “1” if both countries are ASEAN members
β_9	OPEC	Dummy variable, equals “1” if both countries are OPEC or OPEC+ members
β_{10}	APEC	Dummy variable, equals “1” if both countries are APEC members
β_{11}	FORM.USSR	Dummy variable, equals “1” if both countries are former USSR members
β_{12}	SAME.REL	Dummy variable, equals “1” if both countries share the same religion
β_{13}	COMM.LANG	Dummy variable, equals “1” if both countries speak the same language

Source: compiled by the author.

more than 50 countries. The independent variables for its construction are listed in *Table 2*. The sample size amounted to 3,150 observations.

The model equation is as follows:

$$\ln_{EXPORT} = 2,6207 + 1,4792\ln_{GDP_X} + 1,0185\ln_{GDP_I} + \\ + -0,3670\ln_{POP_X} - -0,1724\ln_{POP_I} + -0,0048\ln_{DIST} + \\ + 1,9370EU + 1,7355EAEU + 0,7929ASEAN - \\ - -0,5482OPEC + 0,7147APEC + 0,4499SAME.REL + \\ + 2,4406COMM.LANG. \quad (5)$$

The model coefficients and regression statistics are presented in *Table 3*.

Regression statistics and analysis of variance indicate the statistical significance of the model. The multiple *R* value is 0.788, which suggests a strong relationship between the dependent variable (export volume, ln_GDP_X) and the independent variables (GDP, population, etc.). The *R*-squared value is 0.6210, meaning that 62% of the variation in export volume is explained by the independent variables in the model. The *F*-

Table 3

Model coefficients and regression statistics

Variable	Coefficient	Standard errow	t-statistics	P-value
Y-intersection	2.6207	0.2995	8.7498	< 0.0001
ln_GDP_X	1.4792	0.0344	42.9468	< 0.0001
ln_GDP_I	1.0185	0.0351	28.9874	< 0.0001
ln_POP_X	−0.3670	0.0382	−9.5972	< 0.0001
ln_POP_I	−0.1724	0.0390	−4.4166	< 0.0001
ln_DIST	−0.0048	0.1162	−0.0413	0.9670
EU	1.9370	0.1691	11.4517	< 0.0001
EAEU	1.7355	0.5388	3.2212	0.0013
ASEAN	0.7929	0.4555	1.7408	0.0818
OPEC, OPEC+	−0.5482	0.1044	−5.2522	< 0.0001
APEC	0.7147	0.2613	2.7353	0.0063
SAME.REL	0.4499	0.0888	5.0680	< 0.0001
COMM.LANG	2.4406	0.1658	14.7201	< 0.0001
Regression statistics				
F-test			428.325	
Pr > F			<0.0001	
R^2			0.6210	
Normalized R-squared			0.6195	
Multiple R			0.7880	

Source: compiled by the author.

statistics is 428.325, and the *p*-value tends to approach "0," indicating that the model is overall statistically significant.

Since the *t*-statistic values are high, and the *p*-values are low, the coefficient for the variable ln_DIST is not statistically significant. Therefore, the interpretation of the model coefficients does not suggest a statistical relationship between the forecasted variable ln_EXPORT and the distance between the economic centers of the countries. The most significant factors are as follows:

- the prevalence of a common language of communication, which is essential for international trade and economic relations;
- the membership of both countries in the EU and ASEAN, which indicates the effectiveness of these blocs in promoting international trade and highlights the importance of studying and considering the possibility of adapting their experiences;
- the inclusion of both countries in the EAEU with the opportunity for free trade, which points to the successes of the union in the area of economic integration.

Quantitative interpretation of the coefficients for the dummy variables in this model can also be carried out using the formula described earlier:

$$R = (e^{\beta_n} - 1) * 100\%. \quad (6)$$

This allows us to conclude that the greatest effect on bilateral trade comes from joining the EU and the EAEU. According to the results, membership in the EU allows for an almost sixfold (594%) increase in mutual trade growth, while membership in the EAEU results in nearly a fivefold (467%) increase.

Thus, the results of both models highlight the importance of economic integration and confirm the effectiveness of the EAEU for trade and economic cooperation. Continuing and intensifying efforts to conclude and implement a Free Trade Agreement between the EAEU and Iran will not only contribute to increasing trade volume but also to diversifying the commodity structure, which, in turn, will ensure economic stability for both parties.

CONCLUSION

The sanctions imposed on Russia and Iran dictate the need to find new partners and markets, making bilateral trade relations strategically important.

Both sides are interested in developing trade, as the diversification of suppliers and markets is a key element in ensuring economic security. In the context of global instability and sanctions pressure, diversification helps mitigate risks associated with dependence on a limited number of trading partners.

The econometric models discussed in the article, based on the gravity model approach, demonstrate a strong statistical relationship between joining effective trade alliances and the growth of bilateral trade, which positively affects economic development. The conducted econometric analysis suggests that there is potential for a multiple increase in trade turnover between Iran and the members of the EAEU, including Russia. Strengthening trade relations between Russia and Iran could become an important factor in stimulating economic growth in both countries.

The results highlight the importance of deepening cooperation with Iran within the framework of the Eurasian Economic Union, as it is beneficial for all its members.

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Russia and China: Strategy and Tactics of ESG-Interaction

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ABSTRACT

The relevance of the topic is due to the strengthening of the Asian vector of Russian interaction. In the context of increasing cross-country interaction, when building ESG policy, it is important to determine the strategy and tactics of ESG-interaction, points of contact and factors for further growth, which will be **the purpose** of this work. The theoretical basis was the work of domestic and foreign authors. This study uses not only general **methods** of dialectical cognition, logical analysis and synthesis, but also methods of sociological research in the form of surveys and interviews. The expert opinion of experts, including one of the author, who has direct experience in trade cooperation with the People's Republic of China, will allow the full coverage of the entire range of problems on the designated topic. **The results of the study** showed a commonality in the strategy of socio-economic development and innovative growth of the two countries. Tactically, the features of the implementation of the ESG policy are highlighted, which are the basis for the further growth of ESG cooperation between Russia and China. Specific projects are presented, and prospects for cooperation are outlined. **The scientific novelty** consists in finding the specificity and commonality of ESG interests of the two countries in the process of building ESG policy, which will be valuable for individual researchers and the scientific community. Assessing the prospects for further growth points, this will make it possible to take into account ESG tactics and adjust strategies for further interaction. This is certainly important for businesses and decision makers in the field of ESG and sustainable development. The indicated **practical significance** is not limited to these areas.

Keywords: ESG; sustainable development; The Concept of Sustainable Development; Sustainable Development Goals (SDGs); Russia and China; Russian-Chinese cooperation; ESG policy; KSR

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INTRODUCTION

Sustainable development, or ESG, as it is more often termed in the current discourse, has several definitions. However, for the purposes of this study, we will use a simpler and more precise definition, taking into account the topic under consideration. Thus, sustainable development is defined as the development of society while preserving the natural basis for the functioning of mankind [1].

Since the beginning of the millennium, there have been two countries: The Russian Federation and The People's Republic of China, which surpassed the average global growth rates. These two countries can significantly affect the biosphere in the process of their economic development. In this regard, it is imperative to examine the concept of sustainable development or ESG (which can be understood as a set of environmental, economic and managerial principles or a more detailed set of measures for the sustainable development of these countries). The implementation of ESG principles is able to halt the processes of contamination, emissions, waste, etc., which, being a consequence of anthropogenic activity, usually result in the deterioration of the ecology and human welfare.

The acronym "ESG" denotes a combination of environmental (E), social (S) and governance (G) factors, which are regarded as criteria for assessing the sustainability of a country, region or company. The ESG-criteria could be established in three categories: environmental impact, social responsibility and effective organizational management [2].

Initially, the concept of sustainable development was introduced by the international community within the framework of the UN Conference on Environ-

ment and Development. The Conference adopted the Concept of Sustainable Development, aiming to ensure environmental stability, improve the environment through the greening of economic activity. In practice, this involves imposing additional conditions and requirements, such as environmental restrictions, safety measures, social aspects, etc., which results in increased costs and expenses for businesses [3].

In view of these principles, it is imperative to set up definite boundaries for the developing society and provide a framework for cross-country interaction. ESG-interaction involves coordinated actions of nations to address environmental and social problems. In more specific detail, this can be described as a process of interaction on measuring ESG factors and assessing their impact on economic results, as well as minimizing a variety of risks. The concept of ESG stems from the principle of responsible investment, which guides the decision-making process regarding investments. It also involves the establishment of standards and strategy for investors to assess corporate behaviour and future financial indicators of the solvency of the company or state. The implementation of ESG principles can be achieved by means of establishment of an ESG assessment system, non-financial disclosure standards, a rating system, indexes and their impact on future financial performance, social policy and the quality of the management component. The combination of these factors contributes to position ESG as a driving force for the progress of sustainable economic development on a corporate, national or global level [4].

Considering the categories of strategic and tactical planning of the ESG issue in China, and comparing them with the Russian approach to solving ESG problems, it will allow us to get a closer view on the direction of the exact vector of interaction between the two countries, taking into account the common interests and the specific features of both cultures.

ESG IN RUSSIA: STRATEGY AND TACTICS

The implementation of the concept of sustainable development in the Russian Federation dates back to 1992. Notably, Russia has come a long way in this direction since then. Starting from the 1980s, Russia has come through many reforms both politically and economically, while in China the emphasis was on economic reforms, while maintaining political stability. What is also common is that the two state systems are based on the socialist system.

In such circumstances, the adoption of the concept of sustainable development turned out to be similar, and comparison of the two strategies at the first stage showed a commonality in the need for economic development. Only in this case following the "sustainable human development", the sustainable development of socio-natural systems is possible — such was the perception of Mammadov N.M., who pointed out the primacy of the national socio-economic policy [5].

Thus, the concept of the Russian Federation's transition to sustainable development meant the consistent implementation of three stages:

1. Solving acute economic and social problems.
2. Structural transformation of the economy and technical renewal.
3. Harmonious interaction of humanity and nature.

After that, the country went a long way until 2012, when the Russian Federation adopted the first Strategy of the state policy until 2025. In 2015, Russia signed the UN Agenda up to the year of 2030 as a commitment to further transition to sustainable development. Recognition of the importance and building a common strategy of sustainable development for international cooperation began in 2016, when the Concept of the Foreign Policy of the Russian Federation was adopted [6].

Currently, sustainable ESG development is a pressing issue in Russia. Since the country is at the peak of economic structural transformation, it follows the development strategy and tactics of ESG innovation and modernization (*Fig. 1*).

Thus, for Russia, as well as for China, sustainable development is understood as its own path to a stable national economy, gradual reforms and well-developed political, socio-cultural and economic characteristics. Today, Russia, as a country with huge resource potential, is increasingly moving away from socio-economic problems in the policy of sustainable development, moving to the field of deep technical renewal, greening and development of ESG financial mechanisms.

ESG IN CHINA: STRATEGY AND TACTICS

Undoubtedly, ESG is a trendy constantly developing topic in China. The country has been participating in UN conferences on sustainable development since 1972, and in 1996, it adopted sustainable development as a national strategy in the economy, social sphere and ecology. The main **strategic directions** included economic reform, the development of a circular economy, the development of an innovative industries, resource-saving measures and environmental protection [7].

China's strategic plans take into account both the latest developments and long-term planning experience, including the experience of the USSR state strategic planning with a mechanism for formation, development and control [8].

According to experts, nowadays, China is an important player in the global ESG policy. Given the size of the economy, the banking system (4 state-owned banks that are creditors of fossil energy sources) and, consequently, one third of the world's volume of emissions, greenhouse gases, etc., China is in the constant

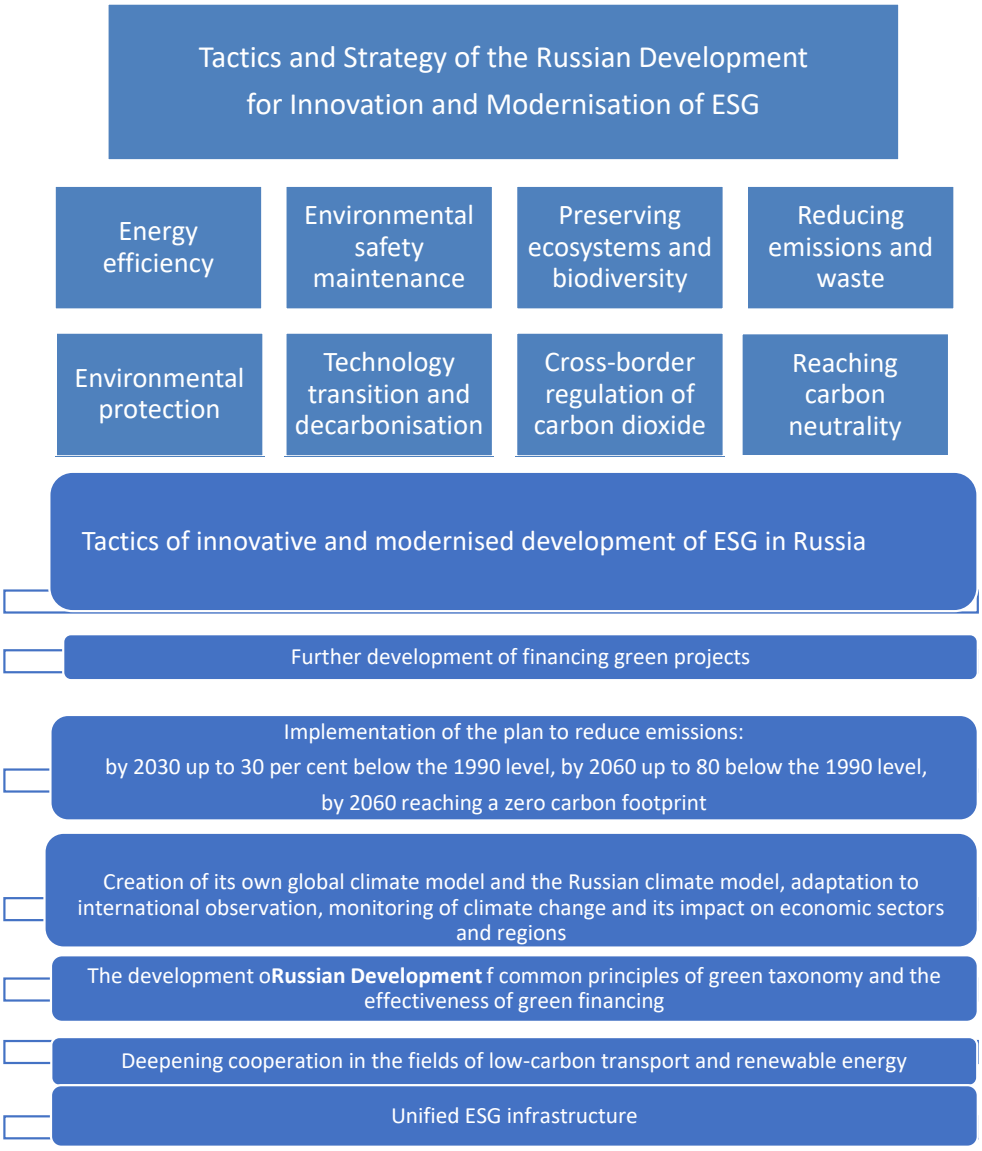

Fig. 1. **Tactics and Strategy of The Russian Development of Innovation and Modernization of ESG**

Source: compiled by the authors based on data: URL: https://roscongress.org/sessions/spief-aktualnost-klimaticheskoy-povestki-v-klyuchevykh-ekonomikakh-evrazii/discussion

focus of interest from investors, providers, financial and technical companies, suppliers of indices, data, non-profit institutions and consulting. The years of reforms have enables the country to make a huge leap forward: China is recognised as a leader in artificial intelligence, 5G telecommunications, the Internet of Things, the electric vehicle industry and battery technologies [9].

However, the country has not immediately become one of the largest economies in the world. In visual terms, the Chinese economy has gone through the following stages of development (see *Table*).

Nowadays, speaking of the progress of China, it is worth noting the tremendous success that the country has reached in recent years. Within the last fifteen years, the country has been the engine of global economic growth, accounting for 35 per cent of global nominal GDP growth, compared with 27 per cent for the USA. As to the China's economic indicators, it is necessary to note stable high growth rates. Thus, by the end of 2023, China's GDP increased by 5.2 per cent and amounted to 126.06 trillion Yuan (17.71 trillion USD).[1] *Figure 2* shows the dynamics of changes in the GDP of the People's Republic of China for the period 2015–2023.

In comparison to the US GDP, China's GDP grew by 66 per cent (from 7 to 73 per cent) in absolute terms from 1990 to 2022, or almost 90 per cent in relative terms.[2]

[1] URL: http: russiancouncil.ru/analytics-and-comments/kitay-poisk-ustoychivogo-rosta/

[2] URL: https: //www.imf.org/ru/Publications/fandd/issues/2023/12/China-bumpy-path-Eswar-Prasad

According to the President of the People's Republic of China, Xi Jinping, "the world has entered a period of unprecedented changes that in no way cancel the main direction of humanity's movement along the path of development and progress. Three global initiatives point the way towards the 'community of the destiny of mankind', whose integral attributes are lasting peace, universal security, prosperity for all countries, openness and inclusiveness, and environmental protection". This is how the leader of China determined his country's position, stressing the need to take into account the provisions of the concept of sustainable development.

The political system in China is characterised as quite stable and largely controlled by the Chairman of the nation, which clearly indicates their nature of decision-making. In fact, most issues are not resolved at the economic level, but at the political level, for example, after negotiations in the regional party committee, a final decision is finally made at the highest level of the Party [10].

In 2015, the UN General Assembly proclaimed the Sustainable Development Goals (SDGs) and set a date for their implementation by the year of 2030 [11].

However, due to the Chinese mentality and the national tradition of building long-term strategic plans, the SDGs' implementation has been significantly delayed. One of the illustrative documents of the SDG achievements was China's VNR Report on Implementation of the 2030 Agenda for Sustainable Development, which, as a follow up to a detailed analysis of China's problem issues, highlighted the achievements and defined the tactics of ESG policy (*Fig. 3*).

Table

Modern Chinese market: stages of transformation

	Timespan	Stages of transformation	Outlined measures
I	1980–2010	Capacity building	The technology exchange market runs the accumulation of new national technologies. Training of a new generation of personnel
II	2010–2025	Building a macroeconomic region	Implementation of the export-import model. The yuan becomes the main settlement currency
III	2017–2035	"Made in China 2025" (the name of China's State program)	China claims to become a global technological leader. A slowdown in growth. The emergence of many risks

Source: compiled by the authors.

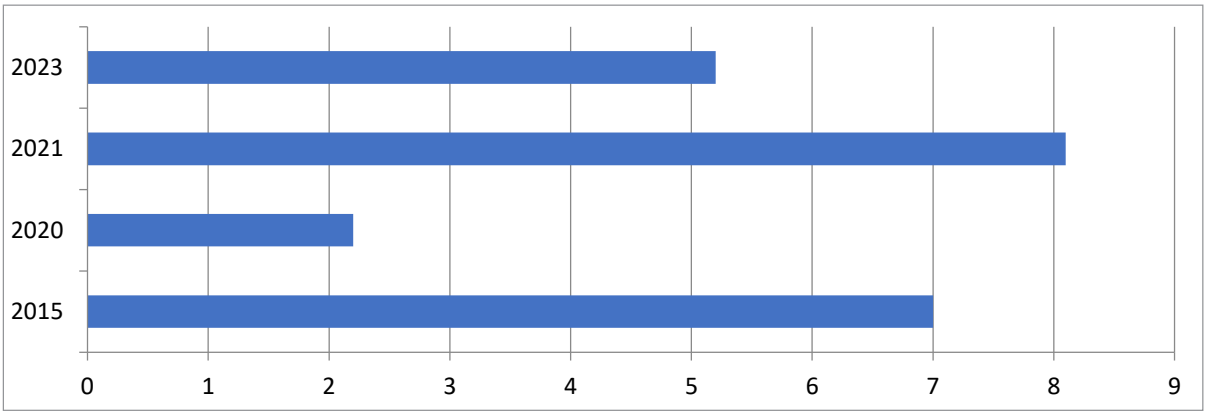

Fig. 2. **Dynamics of China's GDP change in %**

Source: compiled by the authors based on data: URL: http: russiancouncil.ru/analytics-and-comments/kitay-poisk-ustoychivogo-rosta/

Definitely, the tactics of the Chinese approach to the implementation of ESG policy involved a variety of management methods adopted in the White Paper. For example, as to the heads of state-owned enterprises, the most effective tough decision is the discharge from office with confiscation of personal property and in the private sector there involved a whole system of fines. On the other hand, efficiency is promoted by means of the system of tax benefits or lower interest rates on loans etc. [12].

China also turned out to be the first country in history to release in 2015 a national green taxonomy (Green Bond Endorsed Project Catalog), which meant issuing green bonds for projects to finance coal and other fossil energy sources. Besides, most importantly, when a company issues green bonds, it could spend up to 50 per cent of the funds raised for corporate purposes, and without the external conclusion of bonds labeling. By comparison, in the rest of the world the taxonomy assumes no more than 5 per cent used for general corporate working capital or general funding purposes.

Thus, the strengthening of regulation of the country's environmental agenda occurred after 2020, when the Chinese leader proclaimed the objectives to reach carbon neutrality and a peak in carbon dioxide emissions by 2060 [13].

When the Catalog of Green Bond Endorsed Projects was ready, in 2021, the Central Bank of China started to allocate subsidies to banks for financing emission reductions at reduced rates. There were changes due to the unification of domestic Chinese standards with international ones. Currently, the Central Bank of China is developing a taxonomy of transitional financing for carbon-intensive industries (thermal energy, steel and cement production) and agriculture.

According to the Center for Energy and Clean Air Research (CREA), in 2023, green projects in China generated 11.4 trillion Yuan (1.6 trillion USD), which is 30 per cent more compared to 2022. China is preparing to resume voluntary carbon credits. After a 6-year hiatus, trading in carbon units resumed in 2023. From now on, any company or individual can buy them under the new China Certified Emission Reduction (CCER) regulations. The CCER scheme allows quantifying and selling CO_2 emission reductions through projects in forestry, methane utilization, and renewable energy sources. Thus, in 2023, renewable energy projects alone accounted for 40 per cent of China's economic growth.[3]

China is the second top-list issuer of green bonds worldwide, however, due to a lack of standardization and non-compliance with international standards, there are barriers which make it difficult for international investors to buy green bonds. There are three Chinese stock exchanges in Beijing, Shanghai, and Shenzhen. They publish their requirements for the companies to issue their ESG reports in four sections: objectives, strategy, indicators, governance, and risk management. It applies to companies

[3] URL: https://vedomosti.ru/esg/corporate_governance/articles/2024/02/19/1021166-zelenaya-ekonomika-kitaya-nabiraet-oboroti

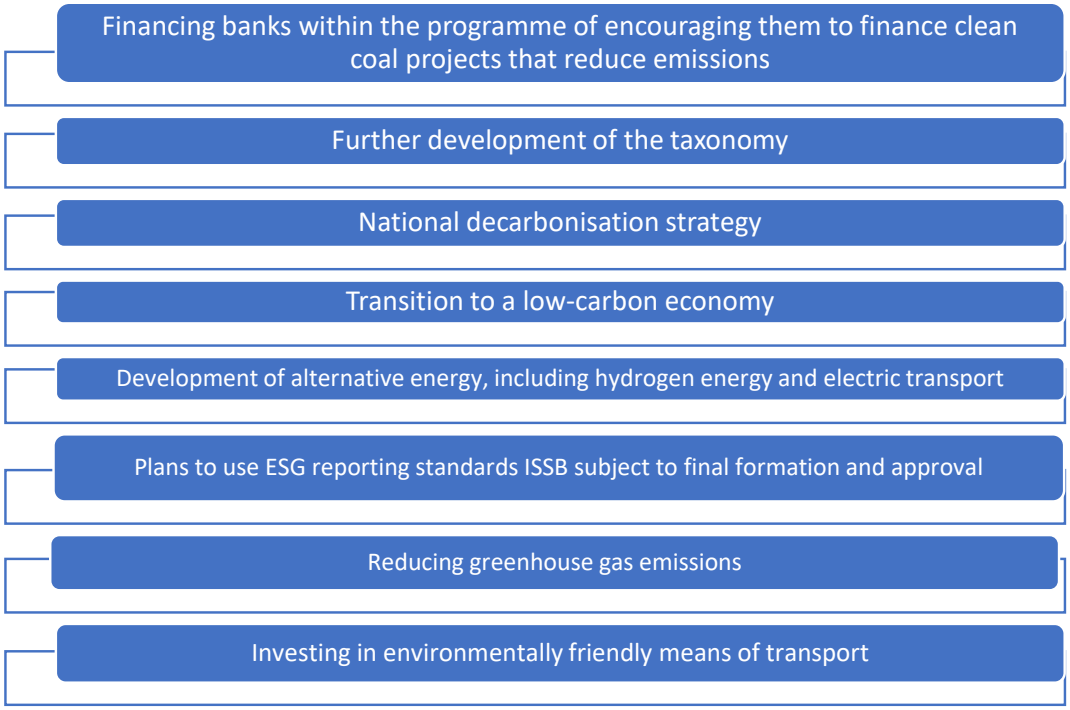

Fig. 3. **The tactics of China's ESG policy**

Source: compiled by the authors based on data. URL: https://sustainabledevelopment.un.org/memberstates/china

whose shares are included in the SSE 180, STAR 50, SZSE 100, ChiNext indices.

Most large companies in China have significant trading connections around the world, and many of them are traded on exchanges in these regions where there are high requirements for ESG standards. As a result, the PRC has to implement these standards and monitor compliance throughout the supply chain. Environmental reporting is also tracked through the value chain [14].

Besides, China plans to compile an annual national greenhouse gas inventory within the framework of curbing emission growth until 2030 and achieving carbon neutrality by 2060 [15].

However, at the same time, there are serious obstacles to sustainable development. There is a problem of uneven regional development in China: the most developed regions are central and eastern and less developed are western and northeastern regions bordering the Russian Federation. This affects the nature of interaction, creating barriers for small and medium-level businesses in competition and restricting access to ecosystem companies such as Alibaba, Huawei and others. At the regional level, there are also social welfare issues related to the difficult environmental situation in individual provinces and regions [16, 17].

It would be a way out of the current situation to obtain additional benefits and preferences, they would adjust market opportunities and they can be obtained by working in such a special trade regime as a free economic zone.

Thus, in recent years, China has created an economic foundation for the development of ESG, and this domain has won a high estimation in the eyes of the country's leadership and it enjoys a real political support. In addition, the country is constantly developing and it actively draws on the achievements of the countries with which it interacts. Moreover, China has managed to integrate its objectives of the concept of sustainable development into its framework of internal priorities. Taking into account global trends in sustainable development, the country primarily evaluates its own interests, adapting the global movement for sustainable development to the needs of its own progress.

RUSSIA AND CHINA: ESG-INTERACTION AND PROSPECTS

Nowadays, Asian countries are visualised by Russia as very promising partners for development of mutually beneficial cooperation. No wonder, Asia is the leading region in terms of GDP, and according to IMF forecasts, it is the only region that is be able to increase GDP from 31.8 per cent (in 2011) to 40.8 per cent (by 2027).[4]

China is the undisputed leader here. In this regard, Russian businesses should pay special attention to the Chinese market. Joint foreign economic projects can not only bring the expected profit, but also raise businesses to another level, as they diversify their market strategies according to modern ESG practices. Nowadays, China enters into a new technological era with the development of energy decarbonisation methods, taking into account the level of CO_2 emissions and greenhouse gas emissions. There are also promising projects for the development of electric vehicles, "green" buildings, energy efficiency solutions, the use of sustainable fuels ("green" ammonia, methanol, hydrogen), the production of "green" steel and carbon capture, utilization and storage, including during coal combustion. All of this lead to the facts, that emission reduction objectives simultaneously represent new opportunities for investment in green technologies. Consequently, bonds become the most popular instrument for raising financial support for sustainable development projects. This is a non-exhaustive list of joint projects available for joint venture activities between Russia and China.

What does the Russian business mean for the Chinese economy? Below are some Chinese statistics for 2021 on the results of bilateral business activity:

Foreign trade: exports 13th place 67 billion dollars. (2 per cent change in 2020/2021 with an increase of 34 per cent), Russia ranks 11th in imports and 78 billion dollars (2.9 per cent change in 2020/2021: an increase of 37 per cent).[5] The commodity structure of Chinese exports is equipment and mechanical devices (22 per cent). Significant export is the Russian oil. Certain achievements in trade cooperation are envisaged too. Moreover, since 2000, Russian-Chinese trade and economic cooperation has been steadily growing, except the periods of the 2008 global financial crisis and the collapse of the Chinese stock market. Thus, the trade turnover in 2018 amounted to more than 100 billion USD, and in 2023, the trade turnover exceeded 200 billion USD, taking the first place in China in terms of growth rate. Moreover, the supply of products from Russia to China in certain items exceeds 20 per cent of the total volume of imports, which is regarded a threat to national security in China.[6] Never the less, ESG cooperation between the two countries is not yet regular [18].

Unfortunately, today the pressure of sanctions cause a great damage to mutual inter-state cooperation. In the end, it is the common person, who suffers from their consequences, deprived of certain benefits that he was used before, not to mention the summary figures and indicators of the development of the companies and the country. Therefore, countries are forced to reorient to other markets, strengthening international relations with neighboring countries. This is what happened to China, which today considers Russia as a strategic ally in developing joint solutions in the absence of other alternatives [19].

In this regard, in the process of joint work, it is important to take into account the peculiarities of the countries of interaction, primarily, the political and economic environment. Politically, China's current course towards Russia, according to the experts, is coined as "pro-Russian neutrality", which, according to the authors, most fully characterises the Russian policy of the PRC and is more accurately called "a policy without harm and without condemnation". However, everyone understands that due to close cooperation between China and the United States, this situation is highly problematic for China and it definitely hinders the development of relations at least with the European countries. Economically, the policy of "checks and balances", related to trade and economic collaboration, is not so obvious, and is characterised by variability in tactical and strategic terms.

[4] URL: trends.rbc.ru

[5] URL: https://tass-ru.turbopages.org/tass.ru/s/ekonomika/13424783

[6] URL: https://economics.hse.ru/ecjourn /news/881979148.html

Developing international relations, maintaining competitiveness, and export orientation are linked directly to compliance with ESG requirements today. The practice of sustainable financing today illustrates the effectiveness of joint projects. That is why, it is important to create conditions, which clearly describe the ESG requirements of each country. It is a well-known fact, that the growth of investments supports economic growth in the country [20]. However, both countries have a different attitude towards the policy of investment. Practically speaking, Chinese companies avoid investing in start-up projects because of high risks. Most of domestic investments in the country are in the public sector, which usually does not bring high returns [21].

The Government is aware of the need to reform the financial sector and liberalise resource allocation. After the rebalancing of the economy (reducing dependence on investment growth, making household consumption the main driver of GDP growth and ensuring most of the growth at the expense of the services sector, an economic growth policy based on the concept of "dual circulation" was proclaimed, which means supporting the domestic and foreign markets, relying on the domestic market.[7] It is important to emphasise here that it was based on the understanding of the need to increase productivity and move away from low-skilled labour production, and its feature was the increasing role of domestic demand, technological self-sufficiency and domestic innovations for further participation in world trade and finance [22]. However, according to experts, this is not sufficient. It is necessary to carry out a number of concurrent transformations related to increasing the transparency of the policy development process, improving corporate governance and accounting (auditing) standards, and increasing the operational independence of the central bank and regulators.

To implement this policy, China needs foreign technology to modernise its industry, and geopolitical and economic disagreements with the United States and the Western world are limiting access to high-tech products and technologies, as well as to export markets [23].

Nevertheless, "One Belt, one Road" is an example of the implementation of joint logistics projects and building logistics chains, where China owns 90 per cent of ports in Africa and controls most of the logistics chains along these routes [24].

Back in 2016, the Chinese Chamber of Commerce of Importers and Exporters of Metals, Minerals and Chemicals (CCMS), with the support of the OECD, adopted the Guide on Integrated Supply Chain Verification, which provides due diligence recommendations for Chinese companies at any stage of the supply chain. They have adapted this Guide and now they expect their supplier companies to follow it.

In 2022, voluntary guidelines for Chinese companies on ESG reporting disclosure came into force. As to Russia, Methodological recommendations are available for preparation of sustainable development reports of the Ministry of Economic Development of the Russian Federation.

Russian and Chinese companies are actively building up partnerships in the field of sustainable development in such areas as energy cooperation, innovation, ecology, etc. Russian companies, such as Norilsk Nickel, are gradually starting to apply the recommendations of the OECD Guidelines on Responsible Supply Chains and are working to assess the risks of their suppliers by building supply chains of mineral raw materials to the Chinese market. As an example of cooperation to mention is Rosneft and the China National Petroleum Corporation (CNPC), which are co-organizers of the Russian-Chinese Energy Business Forum. The purpose of the forum is to develop bilateral relations in the field of energy, project financing, trade turnover growth, etc. Joint low-carbon development projects include plans to reduce greenhouse gas (methane) emissions, technologies to improve energy efficiency, carbon dioxide capture and storage.

Recently, a course has also been set to outline practical cooperation in the field of banking and insurance activities. Thus, as the latest steps in strengthening cooperation between the two countries, Russia and China sealed the agreements to maintain a high level of settlements in national currencies in trade, investment, lending, and other trade and economic transactions. In order to ensure the stability of mutual trade,

[7] URL: russian.news.cn/2020

strengthen and develop the payment and settlement infrastructure, and ensure the smooth functioning of settlement channels, both countries plan to establish subsidiary banks and branches, open correspondent accounts, and support insurance companies for insurance protection during cargo transportation and international traffic. Besides, most importantly is the mutual recognition of the equivalence of accounting, auditing and supervisory standards, including for the purposes of issuing bonds.[8]

In confirming the vector of close cooperation between Russia and China, it is worth noting the reaction of NATO expressed at the Madrid Summit in 2022 during the debates on the deepening strategic partnership between China and the Russian Federation. Notably, China perceived the New Strategic Concept of NATO as confrontational, which despite a rather high level of economic and technological cooperation with the EU countries, created tension in many areas, thereby predetermining for China a new turn towards Russia.[9]

Finally, it would be appropriate to mention the results of a study conducted by a representative from China, who, during the sociological method of an expert survey, revealed the intercultural differences underlying the practice of corporate social responsibility (CSR). For your information, CSR determines the relationship between society and businesses, applying the balance of responsibility to different social groups [25].

In the process of building of cross-country cooperation, it is undoubtedly important to take into account differences in national business cultures and value orientations, which influence corporate policy. China belongs to one of the oldest civilizations, with elements of Han culture based on Confucianism, Legalism, Taoism and Buddhism. Chinese culture cherishes the principles of Confucian ethics, which promotes the ideas of common good and respect for the State. As to the Russian model, it predominantly adheres paternalistic attitudes, which in labor relations is expressed in the higher importance of the company-employee relationship. In addition to taking into account the widespread values of owners (managers), it is characteristic to bear in mind their personal interests and moral values, which are brought up in conditions of hierarchy and culture of family collectivism [26]. The research work also showed recognition of the existence of information responsibility in the structure of society. It is assumed as well, that the **socio-cultural basis** of modern society presupposes the interaction of such information culture with the value-normative models of national cultures [27].

Thus, in addition to the obvious differences in the economic and institutional environment, China has its own value-normative model. However, despite all the differences, the authors also revealed similarities, which consist primarily in collectivism (albeit of a different kind) and distance from power. Both cultural models a common feature of etatism, respect for the state and recognition of its high responsibility for everything that happens in society. Special attention is also drawn to the high role of the state in the People's Republic of China to shape corporate social responsibility policies of companies. This unites the Russian Federation and the People's Republic of China and reflects a high role of the State in the economies of both countries.

CONCLUSIONS

The recent rise in the Asian vector has led to a search for commonalities between such different, but quite serious and significant players in the world market as Russia and China. Thus, in view of specific strategy and tactics of ESG-interaction between two countries, the authors determined following aspects:

1. Russia is currently at the stage of a deep economic structural transformation with the deepening of the innovation and modernisation direction and the development of ESG financial mechanisms. To achieve the chosen strategy, it is necessary to build a mutually beneficial international cooperation within the framework of ESG interaction.

2. China is not only a strategic partner for Russia. It also makes an example of the individualism of the Chinese economic model, where the tandem of authoritarian power and a market economy produces optimal results, and constant variability and adaptation to it leads to impressive results of the country's growth and development.

[8] URL: https: //www.interfax.ru/business/977602

[9] URL: https: //www.imemo.ru/news/events/text/china-in-the-new-nato-strategy

3. A comparative analysis of ESG interaction has revealed commonalities in strategies and tactics, as well as in the normative and value attitudes of the peoples in Russia and China. Thus, socio-economic development, economic growth and innovative development, as well as environmental policy and energy saving are among the points of growth in the interaction between the two countries. Besides, etatism and cronyism of structures determine the similarity in business approaches.

4. In building ESG tactics, it is important to proceed systematically, taking into account the specific national character of China, the peculiarities of the country's formation and development, and deep national roots.

5. While making prognosis for the future, one should perceive that there are no concerns about the slowdown in China's economic growth. According to the authors, the balanced policy of the socialism market in China will still make it possible to build a stable model, which will only make the economy even more stable, if the pace of economic growth slows down.

6. According to the authors, in the current conditions moderate economic growth is possible only with a balance in the ESG directions, which ensures the country stability in domestic and foreign policy.

As a result of the research work, it became clear that good neighborhood, friendship, cooperation and eternal peace, which were laid down back in 2001as the basis for the sustainable development of Russia and China, are actively gaining momentum in the current political conjuncture.

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Digital Transformation in the Labor Market for Disabled Persons (Case Study: an Industrial Company)

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ABSTRACT

The impact of digital transformation of industrial enterprises on the labor prospects of people with disabilities is examined by this publication. Distance or hybrid employment and education are effective tools for providing this category of population with highly paid and prestigious jobs in industrial enterprises. Innovative digital technologies, products, resources, and services make it easier for enterprises to adapt workplaces to the unique needs of people with disabilities, which, in turn, contribute to successful economic inclusion. The authors explore microeconomic incentives for enterprises and their impact on corporate HR policy in the context of integrating such workers into the field of employment. Modern industrial enterprises cannot be fully competitive without considering the principles of business social responsibility and an inclusive corporate culture. Microeconomic methods are the main ones to evaluate the effectiveness of labor integration programs in the context of digital transformations. Such approach makes it possible to consider the interests of all stakeholders: employers, employees, and the state, as well as to analyze in detail the possibilities of increasing employment and reducing the unemployment rate of people with disabilities.

Keywords: disabled people; digital transformation; automation; distance and hybrid learning; distance and hybrid employment; industry; labor productivity; corporate HR policy; inclusive corporate culture; microeconomic research method

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INTRODUCTION

In our country, people with disabilities (hereinafter referred to as PWD) remain a marginalized group, with very limited publicly available information about them. However, according to estimates from the World Health Organization, they account for approximately 10% of the global population.[1] Data from the Ministry of Labor and Social Protection of the Russian Federation indicate that in 2017, there were 12 million officially registered individuals with disabilities in Russia. When including their family members, social workers, and other stakeholders, it becomes evident that between 25 and 40 million people in the country are directly affected by issues related to PWD on a regular basis [1].

Although business leaders across various industrial sectors are implementing inclusive HR policies and corporate cultures [2], career orientation, access to education, professional development, retraining, and employment for this population remain significant challenges. The industrial sector, which encompasses power generation, extractive industries, and manufacturing, spans across all regions of Russia, with over 50,000 enterprises [4]. The digital transformation (or digitalization) of this economic sector presents new employment opportunities for people with disabilities.

The primary **goal of this study** is to analyze the impact of digital transformation in industrial enterprises on labor market opportunities for PWD. The authors seek to address the following **research questions**: What labor market and professional education trends enable PWD to fully realize their potential? How are industrial enterprises leveraging digitalization to implement new technologies, resources, products, platforms, and services? Which professions in the process of industrial digital transformation are becoming more accessible to PWD?

The focus of this study (**object of the study**) is EBIS LLC (hereinafter referred to as EBIS or the Enterprise), a chemical industry enterprise within the manufacturing sector that specialized in processing various types of plastic packaging waste (crates, bottles, containers, and films) from 2015 to 2022. Although this market segment is relatively small, it holds significant growth potential. The market structure is characterized by monopolistic competition, with key competitors including EcoTechnologies, Komiteks, Fantastic Plastic, and Plarus. EBIS held a leading position in this sector and employed 198 workers, 10% of whom worked remotely.[2]

In 2022, the crisis in Russia's debt market negatively impacted many industrial enterprises. By 2024, TechnoNICOL Corporation, the largest consumer of EBIS products, acquired its production facilities with the intention of implementing strategic plans and investing in this promising market.[3]

This study focuses (**subject of research**) on the digitalization of industrial enterprises, using EBIS as a case study. The analysis is conducted in two key areas: new data processing tools and artificial intelligence (AI) applications, and innovative communication technologies [5]. The successful implementation of EBIS's strategic and investment plans is contingent upon these developments, along with the adoption of both proven and cutting-edge digital resources, products, and services. The benefits of these advancements are particularly evident in industrial facilities, where business process automation plays a crucial role in enhancing efficiency and improving labor productivity.

CHALLENGES IN CAREER GUIDANCE, EDUCATION, AND EMPLOYMENT OF PEOPLE WITH DISABILITIES IN INDUSTRIAL ENTERPRISES: HISTORICAL CONTEXT AND MODERN REALITIES

Employment opportunities for people with disabilities are closely linked to their social

[1] URL: http://www.who.int/topics/disabilities/ru/; http://www.who.int/mediacentre/news/releases/2011/disabilities_20110609/ru/

[2] URL: www.abis-rcl.ru; https://www.e- disclosure.ru/portal/company.aspx?id=37232

[3] URL: https://www.interfax.ru/business/983381

rehabilitation, which includes retraining, professional reskilling, and the continuation of education in their previous fields while considering any lost functional abilities.

Approximately a century ago, Henry Ford, the founder of modern management theory and a pioneer of industrial enterprise, analyzed the potential for employing PWD. He argued that if industrialists were to hire them at lower wages while expecting reduced productivity, it would contradict the fundamental principles of business. The best approach was to place PWD on an equal footing with other workers. Business and charity should not be intertwined, as the primary goal of business is production [6].

Ford also noted that people often assume working at full capacity is the key to maximizing productivity. However, a detailed examination of industrial workflows can help confirm or refute this assumption. For instance, what is the nature of the physical labor required — is it light, moderate, or heavy? Is the workspace damp or dry, clean or dirty? Does the job require two hands or just one?

Labor standardization in a typical industrial enterprise of the 20th century was structured as follows: there were 7,882 distinct job functions, with 949 specifically designed for individuals in peak physical condition and 3,338 for those with normal physical strength. The remaining 3,595 tasks could be performed by men with lower physical strength, women with average strength, and teenagers. Additionally, 670 jobs were accessible to individuals without legs, 2,637 to those with one leg, 715 to individuals with one arm, 10 to blind workers, and 2 to those without arms.

This demonstrates that a well-developed industrial enterprise is fully capable of providing high-paying jobs to a large number of PWD. From an economic standpoint, efficient labor division within factories and manufacturing plants can reduce the financial burden on social welfare programs while allowing PWD to obtain prestigious, socially valued professions — far superior to the historically common yet low-income handicraft work, such as basket weaving [6].

Consequently, enhancing professional qualifications, retraining, and integrating PWD into the workforce not only boosts overall labor productivity but also expands employment opportunities and contributes to overcoming widespread poverty [7].

DIGITAL TRANSFORMATION OF INDUSTRIAL ENTERPRISES: EMPLOYMENT AND WORKFORCE TRAINING

In today's industrial landscape, fully automated enterprises with integrated production and logistics chains have emerged as tangible examples of digital transformation. These businesses successfully implement the paradigms of "Industry 3.0" and "Industry 4.0" in practice [8].

In this study, digitalization is understood as the process of integrating advanced data processing methods and artificial intelligence (AI) technologies, including digital solutions such as "1C: Enterprise", "Project Expert", "Consultant Plus" (a legal reference system), GIS technologies, Deductor, Bizagi Modeler, Designer, MS SharePoint, and MS Power BI. Additionally, the study highlights the significance of enhanced communication technologies via global computing networks, fostering collective intelligence across the planet (1C: Bitrix, Mind42, Coggle, MindMeister, and XMind).

Cloud-based solutions, particularly "1C: Enterprise", are gaining widespread popularity (see *Fig. 1*). This platform enables employees to work remotely and in hybrid formats, providing significant flexibility. It also simplifies self-paced learning of various software tools and enterprise solutions, including "1C: ERP Enterprise Management", "1C: Small Business Management", "1C: Accounting", "1C: Payroll and HR Management (PROF and CORP)", 1C: Bitrix, and "1C: Trade Management".

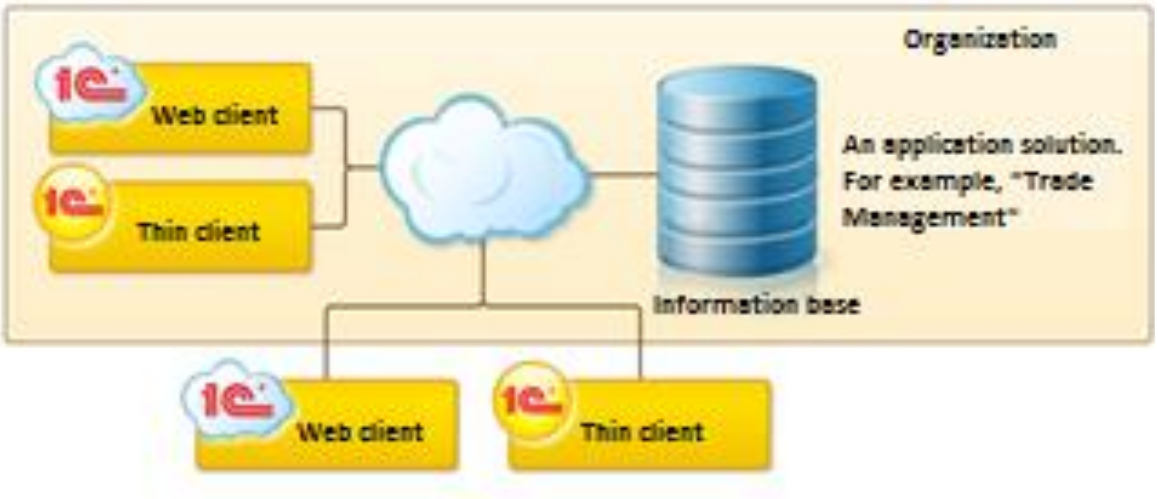

Fig. 1. **Cloud service "1C: Enterprise 8" inside an industrial enterprise**

Source: URL: https://v8.1c.ru/platforma/oblachnye-tehnologii

Essentially, digital transformation facilitates the creation of specialized employment and learning conditions for professionals such as accountants, auditors, business analysts, managers, economists, marketers, and logisticians. The only fundamental requirement for this approach is access to a personal computer (laptop, tablet, or another device) with a stable internet connection.

Another key digital solution, Project Expert, is designed to support remote and hybrid work for financial planners, investment analysts, and risk managers. It enables the development of economic calculations, business plans, financial reporting, and risk assessments that comply with the standards of the United Nations Industrial Development Organization[4] (UNIDO) and the International Accounting Standards[5] (IAS).

The application of geographic information systems (GIS technologies) in spatial planning, urban development, and real estate is also closely linked to the digitalization of industrial enterprises. For instance, cloud-based GIS platforms such as QGIS[6] allow for the creation of real-time thematic maps, which help visualize spatial models. One example is ranking districts in the Krasnodar region based on social vulnerability levels (see *Fig. 2*). Such data can be used to optimize industrial site locations and plan insurance costs for natural disaster risks.

The next phase of digital transformation in industrial enterprises will involve the implementation of technologies based on artificial intelligence (AI), neural networks, and expert systems, including the development of the AI-powered Waste Sorting System.

Currently, the development of such technologies involves a diverse team of IT specialists: a programmer-designer — responsible for design, application logic programming, server-side development, testing, and implementation of additional features; an application programmer for real-time video processing — focuses on developing software solutions for processing video content in real-time; an AI specialist works on neural networks, expert systems, and other AI-driven solutions; a frontend and backend developer handles mobile application layout design, programming of both frontend and backend logic, testing, and additional functionality integration; a system architect and analyst responsible for task allocation within the project, technical and software implementation analysis, architectural recommendations, product evalu-

[4] United Nations Industrial Development Organization.

[5] International Financial Reporting Standards.

[6] URL: https://www.qgiscloud.com/

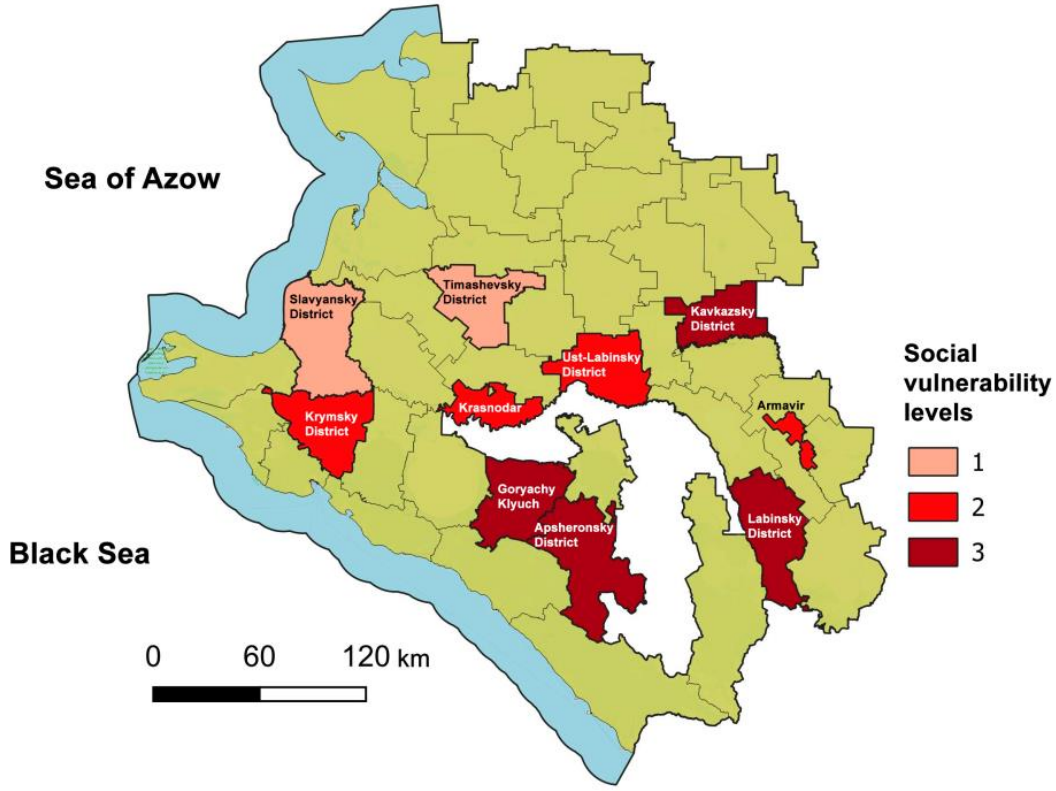

Fig. 2. **GIS-technologies for visualizing the ranking of Krasnodar krai's counties by social vulnerability**

Source: compiled by the authors.

ation, and technical specification development. Additionally, the development process involves a marketing analyst, who conducts usability testing of prototypes, assesses consumer ergonomics, evaluates actual costs, and ensures the final product aligns with technical specifications; a project manager who oversees task distribution, monitors and analyzes technical and software implementation, evaluates the final product, submits patent applications, and manages project documentation.

IMPACT OF DIGITAL TRANSFORMATION IN INDUSTRY ON CAREER GUIDANCE, EDUCATION, AND EMPLOYMENT FOR PEOPLE WITH DISABILITIES

The rapid expansion of digitalization has sparked a revolution in assistive technologies for PWDs. A significant achievement of this transformation is the increased access to quality education, acquisition of new professional skills, and employment opportunities in high-demand industries [9].

For individuals with visual, auditory, or motor impairments, various digital products, resources, and services offer new opportunities. However, their distribution remains uneven. Global university policies on equal access for PWDs classify countries into four groups, ranging from "beginner" to "advanced." Russia falls somewhere in the middle, as it is still in the early stages of implementing inclusive policies [10].

The experience of "advanced" nations demonstrates that the use of robotics, virtual reality, and supportive communication technologies significantly enhances the academic and social success of PWDs in colleges, universities, and professional development courses. This, in turn,

positively impacts their participation in the labor market.

Close collaboration between PWDs, their families, educators, engineers, and inclusion specialists fosters the development of digital products based on universal design principles. These innovations include software and hardware solutions tailored to individuals with autism, cognitive impairments, blindness, and low vision [11, 12].

Both asynchronous and synchronous courses in distance and hybrid learning provide PWDs with the opportunity to access quality education and secure well-paid, prestigious jobs. For example, the Financial University under the Government of the Russian Federation actively integrates digital tools to develop design thinking and professional competencies for PWDs in human resource management, marketing, advertising, and public relations.[7] To enhance learning experiences and optimize course delivery, universities increasingly rely on digital mind-mapping tools such as Mind42, Coggle, MindMeister, and XMind. These platforms help organize complex information, improve engagement, and facilitate knowledge retention.

Gamification should not be dismissed — many games are available through a web browser. For example, Kahoot! is a game-based learning platform and an effective educational technology. Its advantages include the ability to complete tasks of various formats remotely, the elimination of subjective factors in knowledge assessment, the option for educators to flexibly manage time for different questions, identify the most challenging ones, and evaluate the speed of correct responses.

What benefits do people with disabilities gain from the digital transformation of industrial enterprises? The use of the "1C: Enterprise" cloud service provides the following advantages. First, there is no need to purchase application programs for installation on a home computer, worry about their administration, configuration, and timely updates, or back up and restore data from information databases after unforeseen failures, power outages, etc. Second, the need for an expensive personal computer with high processing power is reduced; there is no longer a necessity to hire maintenance staff and qualified specialists. Various tasks can be performed

[7] Vasilyeva E.V. Design Thinking. Methodology of Creative Development. Textbook. Moscow: Knorus; 2023

Fig. 3. **Digital guide-dog: description**

Source: compiled by the authors.

remotely, and additional individual expenses are minimized. Third, there is the ability to pause and resume work or studies at any time — i.e., the rhythm is set by the individuals with disabilities themselves, who only need to submit a request on the website[8] to gain access to the service.

It appears that this method of professional development is of paramount importance for people with disabilities. Moreover, it is worth noting separately that the portal interface is fully identical to commercial solutions in the field of online tools, meaning that users will not experience any discomfort when transitioning to a work environment for future employment.

In the near future, AI, neural networks, and expert systems will be used to develop innovative products such as the "Digital Sign Language Interpreter," "Flood Alert," and "Digital Guide Dog" (see *Fig. 3*).

The implementation of the "Flood Alert" system at industrial enterprises will help ensure safe working conditions for employees with cognitive impairments, blindness, and low vision, reduce potential economic and environmental damage, and increase labor productivity. All of this will become possible through timely notifications about the occurrence of natural and related man-made disasters in the vicinity of the employer's location, which is especially relevant for PWDs [13, 14].

The use of the "Digital Guide Dog" will significantly improve spatial orientation for the aforementioned group of people, while the "Digital Sign Language Interpreter" will enhance the productivity of deaf and hard-of-hearing employees at industrial enterprises.

RESEARCH METHODS

For an effective analysis of business ideas for the implementation of digital technologies, products, and resources at the company level, a standardized procedure is required, which includes all stages, starting from the needs analysis and ending with the evaluation of effectiveness (*Fig. 4*).

At the final stage, a reliable evaluation of the effectiveness of strategic and investment alternatives "before implementation" and "after implementation" is carried out through a "cost-benefit analysis" (**CBA**), as well as the concept of the time value of money and discounted cash flow analysis (**DCF**).

Since the movement of money adequately reflects economic processes, to determine the effectiveness of resources and products proposed for implementation during digital transformation, the industrial enterprise is considered as a generator of cash flows. The discount rate accounts for the time value of

[8] URL: https://online.1c.ru/

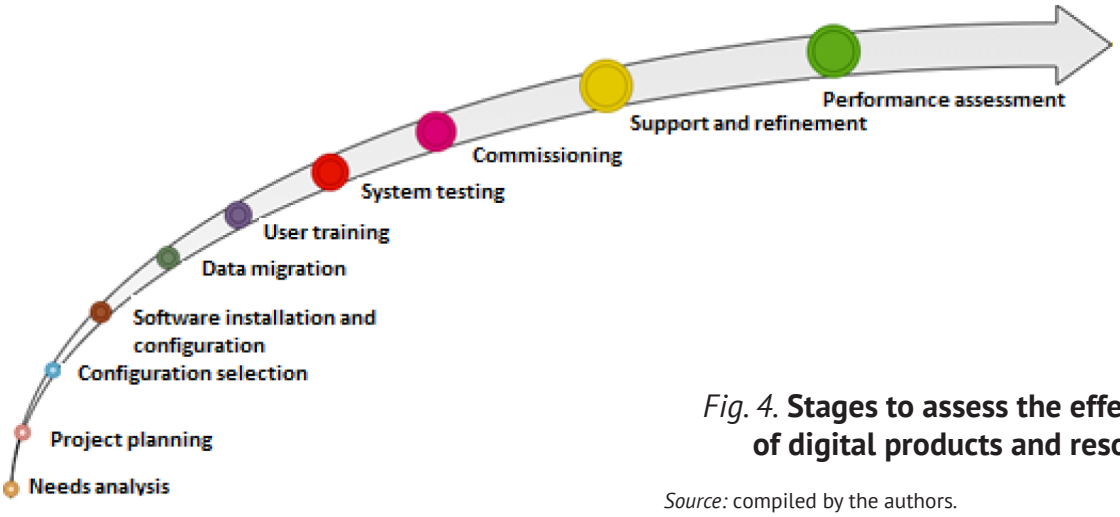

Fig. 4. **Stages to assess the effectiveness of digital products and resources**

Source: compiled by the authors.

money. As a result, performance indicators are calculated, which can be used to assess the effectiveness of the decisions made.

Economic calculations based on DCF involve the use of the following formulas [15, 16][9]:

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+i)^t}, \quad (1)$$

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+IRR)^t} - Io = 0, \quad (2)$$

$$PP = \min n, \; at \; which \; \sum_{t=1}^{n} CF_t \geq Io, \quad (3)$$

$$DPP = \min n, \; at \; which \; \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t} \geq Io, \quad (4)$$

where NPV is the net present value of the project (net present value); CF_t is the net cash flow for a specific time period t; i is the discount rate or the return rate of alternative investments; t is the time index; $t = 1, 2, \ldots, n$; n is the project implementation period; IRR is the internal rate of return; I_o is the initial investment (the amount of initial investment); PP is the simple payback period; DPP is the discounted payback period.

[9] URL: https://financeformulas.net

RESULTS AND DISCUSSION

The first stage of the strategic development plan for EBIS until 2030, within the framework of digital transformation, involved the use of cloud services such as "1C: Enterprise," "1C: Bitrix," the legal reference system "Consultant Plus," Mind42, and Project Expert. The implementation of these digital products by the company's management significantly improved the efficiency of business processes, including the automation of integrated production-logistics chains, financial and management accounting, and resource management. As a result, employees' work was greatly simplified, and the time required to complete routine tasks was reduced by more than 30%. This allowed the management team to focus on more important aspects of the business and increased overall labor productivity.

In the second stage, the company's management plans to implement innovative digital products based on AI and GIS technologies to improve the efficiency of waste sorting, logistics,

Table

Annual savings in the production costs of industrial enterprise, million rubles

Parameter	Before introduction	After introduction	Savings (CBA method)	
			without discounting	with discounting (DCF method)
Outstaffing costs	198	123	75	61
Rent	152	121	31	25
Other operating expenses	651	564	87	71
Total	1 001	808	193	157

Source: compiled by the authors.

and internal personnel and social policies. After the successful pilot implementation of neural network technologies at one of the production sites, the plan is to scale these digital solutions to other sites.

The results of the evaluation of the first stage, conducted using the cloud service Project Expert, show that the implementation of digital technologies can lead to a reduction in operational costs by 15–20% (see *Table*).

With annual company expenses amounting to approximately 1 billion rubles, savings can reach 150–200 million rubles per year, including reductions in outsourcing costs (personnel leasing, hybrid work mode). These figures are made possible by process optimization and a decrease in errors in financial and management accounting.

The implementation of these innovations requires investments in server equipment, software, information systems, and their testing, as well as funds for organizing qualification improvement courses, training sessions, and workshops for staff, totaling 61 million rubles.

According to formulas (1)–(4), the net cash flow of the project, without considering discounting, is 132 million rubles, and with discounting (*NPV*) at a rate of 23%, it amounts to 107 million rubles. The simple (*PP*) and discounted payback period (*DPP*) are both less than a year, and the annual internal rate of return (*IRR*) is over 100%.

Thanks to the use of digital technologies, the company's management has employed 14 highly qualified individuals with disabilities (PWD) for remote and hybrid work, who have lower salary expectations. This confirms the feasibility of such investment projects and emphasizes the importance of digitalization in achieving competitive advantages and conducting effective corporate human resources policies.

CONCLUSION

Digital transformation creates a solid foundation for the inclusive development of industrial enterprises. Modern technologies contribute to the transformation of traditional industries, improve human resource policies, and foster an inclusive corporate culture. New opportunities are emerging in the modern labor market for remote and hybrid work as well as professional education. For PWDs, new prospects are opening up in the fields of vocational orientation, education, and employment.

This population group now has the chance to secure well-paid and prestigious jobs in areas such as economics (accountant, financial controller, investment analyst, economic planner, marketing analyst, advertising and public relations specialist, risk manager), production and logistics (business analyst, logistician, supply chain specialist, manager), IT (programmer-designer, AI programmer, frontend developer, and architect-analyst), law (audit assistant, tax specialist, and legal assistant), and GIS technologies (spatial planning visualization specialist, urban planning, real estate location, and environmental safety specialist).

The novelty of this study lies in the description of a methodology for determining the effectiveness of the implementation of digital products, resources, services, etc., the application of which allows for the continuous improvement of business processes, automation of production, the introduction of digital innovations, and increased labor productivity.

Thanks to this methodology, professions have been identified where PWDs have the opportunity to study and work remotely or in a hybrid mode using cloud-based digital products. For instance, "1C: Enterprise" is necessary for accountants, financial controllers, economic planners, and business analysts; 1C: Bitrix is designed for professionals in advertising, human resource management, and corporate culture; the "Consultant Plus" reference and legal system can be used in the education and work of tax specialists, legal assistants, and internal auditors; Mind42 is ideal for marketing ana-

lysts and PR managers to develop professional competencies; "Project Expert" increases employment chances for investment analysts and risk managers.

Thus, taking into account that there are over 50,000 industrial enterprises in Russia, the macroeconomic effect of digitalization will be additional employment for those with limited mobility, blindness, and visual impairments, people with respiratory diseases, and other categories of PWDs. The total number of newly employed individuals could rise to 1 million people.

Further research should be conducted using both quantitative and qualitative methods. The latter, through expert surveys (including labor market and inclusive vocational education specialists), will allow for a more detailed list of relevant professions for remote and hybrid employment for people with disabilities.

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Centralization, Hierarchy and Management Control in Modern Corporate Groups

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ABSTRACT

Despite the lack of a clear definition of the term «corporate group» in Russian legislation, experts consider it important to use it, as it has become a widespread phenomenon. Moreover, Moreover, corporate groups are currently reinforcing hierarchical structures once again. Having carefully studied the top 20 and top 10 global and domestic giants, the authors conclude that these entities remain stable and observe a slowdown in decentralization processes, even where horizontal and network structures were previously predicted. The largest corporations in the Russian Federation consist of complex, extensive networks of subsidiaries and affiliated entities, characterized by a high level of centralization despite significant business and legal entity diversification. Therefore, the authors argue that within the scope of this discussion, it is necessary to develop and implement advanced financial management models.

Keywords: corporate group; holding structure; subsidiary; centralization; managerial control

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INTRODUCTION

Currently, the large Russian corporate enterprises, which were founded in the 1990s-2000s, undergo institutionally structural transformations. A comprehensive scientific introspection of their snowballing development dwindles down to nothing. At the same time, these major companies keep expanding their operations and grow in size, including by means of setting up or acquiring non-core subsidiaries. Sometimes this occurs due to the accumulation of large financial resources, or strengthening of control over technologically related entities, or diversification of business for risk reduction. However, in this case feasible arguments are not always in line with economic reasons, rather on the contrary: when mono-profile-industry companies distance themselves from the general value chain, this reduces financial result.

Modern large and organizational-complex enterprises can be transformed due to both acquisitions of businesses (if they aim to increase influence, expand control and market share) and fragmentation of existing companies. Within the framework of vertical integration, they merge companies involved in the production of raw materials or in the provision of value-added services in so-to-say "anchor industry". In case of such major companies, the companies they merge may be operating in the industries not directly related to the core business of the Majors, but could be valuable to reduce risks or gain access to new markets. As these major corporations grow, they can be split into independent subsidiary companies to provide them with a greater autonomy and flexibility in decision-making process. Such splitting often simplifies the management of the company and makes it more efficient, used to reduce the tax burden. The choice of integration or diversification strategy depends on specific conditions and objectives.

A large and complex organisational enterprise is constantly balancing between its increasing size and sustainability, ensuring manageability and autonomy of the periphery, increasing control over the value chain and regulatory constraints. It seems important to determine some general trends. Therefore, the current objective of this research work is to examine the factor of consistency for composition of large groups of companies, determine the logic of their organisational and managerial development, as well as the structural dynamics from open sources.

GROUP OF COMPANIES AS A COMPLEX SYSTEM WITH INCREASED NEED FOR MANAGEMENT AND CONTROL: CONCEPT DEFINITION

Previously, the authors made attempts to provide a definition of terminology for such large-scale institutional enterprises structurally similar to holdings with a relatively large number of interrelated economic entities involved, vertically integrated enterprises and enterprise groups. We shall summarise again the conclusions drawn earlier [1], which should be taken into account in the context of this article.

In most cases, an enterprise group is understood as a unity of legally independent, however, more or less interdependent, enterprises united by a centralised control system [2, 3]. As a rule, the interdependence of entities within their group is based on common, or related sources of authorised capital, which in its turn determines the significance of this concept for legal aspect, accounting and reporting.

Certain mechanisms allow to visualise several legal entities involved to reach a common objective. For instance, the financial accounting legislation allows to set up consolidated legitimate unities of financial accounting among groups of companies linked by common control.[1] A group can be considered a single legal entity that controls another legal entity (for example, via capital participation),[2] or a holding company and its subsidiaries [4].

[1] The Federal Law of the Russian Federation No. 208-FZ dated 27.07.2010 "On Consolidated Financial Reporting" (as last amended). URL: https://www.consultant.ru/document/cons_doc_LAW_103021/

[2] The Federal Law of the Russian Federation No. 395–1 dated 02.12.1990 "On Banks and Banking Activities" (as last amended). URL: https://www.consultant.ru/document/cons_doc_LAW_5842/

In addition, some legal acts use the notion of "groups of individuals".[3] There are also a few other legal concepts close in the meaning of the terminologies "affiliated persons" (Article 53.2 of the Civil Code of the Russian Federation), "interdependent persons" (Article 105.1 of the Tax Code of the Russian Federation), "consolidated group of taxpayers" (Article 25.2 of the Tax Code of the Russian Federation).

In addition, Russian legislation uses the concept of "subsidiary" and a very close concept used in practice, such as "affiliated company".

Relatively recent attempts to define and made systematic the concept of "group of enterprises" are available below in *Table 1*.

Therefore, there exists a gap between legislation and established practice. This probably occurs due

[3] The Federal Law of the Russian Federation No. 135-FZ dated 26.07.2006 "On the Protection of Competition" (as last amended). URL: https://www.consultant.ru/document/cons_doc_LAW_61763/

Table 1

Diversity of interpretations of the term "corporate group" by Russian experts

Name of the expert and source	Definition	Definition focused on:
Osipenko O.V. — Russian holdings. Expert problems of formation and ensuring development. Moscow. Statute 2008	Companies with connections based on classical subordinate dependence in the field of corporate governance	A full range of corporate connections.
Gruzenkin V.V. — How different types of Russian owners make business and how to build a system of business ownership in a group. Moscow. Buki Vedi 2012	Two or more business companies organised or controlled by one or several individuals whether or not dealing between each other on the basis of legal or other relations and managed from a single centre for the purpose of making a profit.	Common economic interest (profit-making) and single control centre.
Anisimov A.A. Identification of groups of related borrowers. Bankovskoe delo. 2010;(2)	Companies that make a significant impact on the decisions of other organisations (directly or indirectly including through the third parties).	Overall financial decision-making.
Gorodilov M.A., Fetisova O.A. Regarding the concept of "simple" and "complex" groups in the International Financial Reporting Standards (IFRS). Vestnik of the Perm University. Series "Economics". 2012;4(15)	A complex economic system at the macro level with a single parent company and a limited number of subsidiaries and other subordinate companies of next-step lower levels	Indirect participation in affiliates
Panov E.E. The evidence of affiliation of the company to a group of related parties for risk assessment. Vestnik of Omsky University. Series "Economics". 2014;(1)	An association of legal entities operating in the same field, sector of industry designed to solve common problems and protect common interests. All membership companies remain legally independent.	Community of interests (sectoral, current etc.) and legal independence
Zayonchik L.L., Medvedeva M.A. Peculiarities of the analysis of financial stability of a group of enterprises. Scientific-analytical economic journal. 2017;4(15)	A union of several legally independent companies that have joined to achieve common goals and objectives (without integration of shareholdings) which means there is no systemic interdependence between these entities as "parent" or "subsidiary" partnership.	Legal independence "non-holding" capital structure

Source: compiled by the authors.

to a lack of consistency between the branches of law that regulate different types of relationships, including financial, control-and-supervision, etc. However, experts who study the corporate organisation of big business companies still insist, that such phenomenon exists, despite the fact, that current legislation provides no clear definition of such a concept. For example, E.D. Vaisman and A.S. Rudakova, who studied the risks of enterprise groups, insisted on the need to improve integration mechanisms [5], when they identified the complexity of legal definition of ownership and decision-making. As regards T.V. Ignatova, who tends to accept economic interrelation of legal entities in enterprise groups, she does not deny either the existence of such entities, or the need to control them from a unified centre [6]. It is quite possible that law enforcement experts in practice are satisfied with the terms and regulatory standards available in the current legislation.

According to the International Financial Reporting Standards, the key factor for defining an enterprise group is the existence of control.[4] The group will include a parent company, controlled entities belonging to one of the following categories: subsidiaries, joint ventures, associates and structured entities. In addition, there exist a conditional "centre" and "periphery", which operate differently in financial and economic activities of the group. The control system becomes more and more complex as the size of the company increases.

An enterprise group is a system with all of its key characteristics, including a single architecture and infrastructure; a set of business units with a single decision-making centre; a set of private objectives understood as a common goal; and internal transactions. Traditionally, such large systems include a significant number of elements, meanwhile complex systems involve multiple, multidirectional and mediated links [7].

In addition to the above, the nature of the links is so diverse that there is always a risk in overlooking one of them, or not recognise or identify it by mistake, which could lead to a constant increase in the entropy of the system and a threat to its existence. Complicated property, or other economic, financial and investment relations, issues of operational management and decision-making become in one way or another related to the economic interests of separate groups or specific people, and this requires a high-quality information infrastructure, the demand for which is not always recognised and, moreover, not always implemented.

Nevertheless, despite the occurring management problems that arise, a large system is more sustainable. It is able to reserve capacity resources by means of generating subsidiaries that can move in the business to take care of a temporary problem in one of the areas. Centralised management functions at the level of a parent company allow to manage financial flows more efficiently by means of investing resources in more promising venues or in those ones subject to seasonal or market fluctuations, thereby smoothing out fluctuating shocks. If compared to relatively small, autonomous enterprises, a large, stable company can attract significant investment and reduce the cost of borrowing by means of a higher credit rating, due to its diversification.

Thus, the definition of "an enterprise group" means for us a complex system of relationships and an organisational form that is not a legal entity, but a whole unity of independent, but legally related business entities with a common goal and a centralised planning and control system, one of the main results of which is optimising the efficiency of the "anchor business" management.

STRUCTURES OF THE WORLD'S LARGEST COMPANIES: HYPOTHESIS, PROBLEM STATEMENT, BASELINE DATA AND RESEARCH METHODOLOGY

In the recent years, there has been identified a tendency of a clear shift from decentralisation to centralisation for the management of large companies. This is not a throwback, but rather an evolution triggered by new realities. The reason for the trends of 20 or 30 years ago was the following: it was technologically impossible to supervise effectively a large number of subsidiaries established

[4] URL: https://finotchet.ru/articles/89/

throughout a vast territory of the world and operating under different regulatory regimes. Modern technologies, such as cloud computing, artificial intelligence, or Big Data allow the centralised management not only to control data but also complex processes. Contemporary distribution instruments of supply chains require centralised management. Investors (shareholders) and regulators require a better transparency and control over corporate financial flows. But decentralisation has not vanished completely, modern companies often take a hybrid approach.

Before determining the optimal level of centralisation in enterprise groups, we set out the task to find out whether the sustainability of large business groups is being analysed worldwide and in Russia, as well as how these groups are related to the industry profile of their affiliated companies, and whether they have a tendency towards centralised management.

Thus, the hypothesis of the study is the following: the composition of the top 20 largest companies in the world has changed insignificantly over the period of 2010–2024. In other words, they are sustainable and operate mainly in accordance with a holding model (more centralised) and in some cases — they represent a conglomerate model (more diversified). We also verified the hypothesis that the largest Russian companies are structured according to the group principle, with a tendency towards centralised management.

The most recent ratings of Forbes Global 2000[5] and Forbes (Russia)[6] have filled out the input data. The source Forbes Global 2000 involves the calculation of an integral indicator that aggregates sales, profits, assets and market value. We used open and reliable sources, mainly published on official companies' websites for interpretation of the data regarding the structure of the enterprise groups. Forbes (Russia) publishes IFRS financial results, as in the recent years the majority of large Russian companies do not disclose their volumetric indicators and their market value estimates are neither enough relevant, nor valid. For its analysis, we used data on the composition of an enterprise group (subsidiaries) from the analytical aggregator of counterparty checks. Random double-checking of the data of the companies' websites and their financial statements allowed evaluating the quality of this data.

[5] URL: www.forbes.com/global2000

[6] URL: https://www.forbes.ru/biznes/497814–100-krupnejsih-kompanij-rossii-po-cistoj-pribyli-2023-rejting-forbes

STUDY FINDINGS

The ratings of the world's top largest companies, which in fact represent groups of companies, are quite dynamic (*Table 2*). It is worth noting that Forbes Global 2000 takes into account four indicators: sales, profits, assets and market value. In general, the composition structure of the top 20 global largest companies has not changed much (maximum by 10–15 per cent) over the period under review. At the same time, the ranking of companies turns out quite mobile.

Table 2 illustrates that the profile of banking, as well as oil and gas sectors dominate among the largest companies. IT companies outsmart manufacturing giants of the automotive, traditional energy and telecommunication sectors. Therefore, the largest groups are those with complex networks of subsidiaries and affiliates.

The banking sector is represented by giants from the USA and People's Republic of China with insignificantly diversified holdings and conglomerates with broad (JPMorgan Chase, Bank ICBC, Agricultural Bank of China, HSBC Holdings) and relatively narrow (China Construction Bank, Bank of China, Wells Fargo) particular sector, ranging from diversified banking to asset management (Bank of America) and trusts. China Construction Bank has a subsidiary, a construction cooperative, and Bank of China has a company specialised in aircraft leasing.

Among the top 20 giants, a few low-diversified groups of companies operate in the primary sector (extraction and processing of natural resources). Usually, they are vertically integrated and organised on the principles of complete control over the technology chain and management of related industries which influence the core business, starting from R&D, geological exploration and finally to the sale

Table 2

Changes in the ranking of the top 20 largest public companies in 2010, 2014, 2018 and 2024

Ranking	2010 r.	2014 r.	2018 r.	2024 r.
1	JPMorgan Chase (USA)	Bank ICBC (China)	Bank ICBC (China)	JPMorgan Chase (USA)
2	General Electric Company (GE) (USA)	China Construction Bank (China)	China Construction Bank (China)	Berkshire Hathaway (USA)
3	Bank of America (USA)	The Agricultural Bank of China (China)	JPMorgan Chase (USA)	Saudi Arabian Oil Company (Saudi Aramco) (Saudi Arabia)
4	Exxon Mobil Corporation (USA)	JPMorgan Chase (USA)	Berkshire Hathaway (USA)	Bank ICBC (China)
5	Bank ICBC (China)	Berkshire Hathaway (USA)	The Agricultural Bank of China (China)	Bank of America (USA)
6	Banco Santander (Spain)	Exxon Mobil Corporation (USA)	Bank of America (USA)	Amazon (USA)
7	Wells Fargo (USA)	General Electric Company (GE) (USA)	Wells Fargo (USA)	China Construction Bank (China)
8	HSBC Holdings (UK)	Wells Fargo (USA)	Apple (USA)	Microsoft (USA)
9	Royal Dutch Shell (Netherland)	Bank of China (China)	Bank of China (China)	Agricultural Bank of China (China)
10	BP (UK)	Petro China (China)	Ping An Insurance (China)	Alphabet (USA)
11	BNP Paribas (France)	Royal Dutch Shell (Netherland)	Royal Dutch Shell (Netherland)	Toyota Motor (Japan)
12	Petro China (China)	Toyota Motor (Japan)	Toyota Motor (Japan)	Apple (USA)
13	AT&T (USA)	Bank of America (USA)	Exxon Mobil Corporation (USA)	Bank of China (China)
14	Walmart (USA)	HSBC Holdings (UK)	Samsung Electronics (South Korea)	ExxonMobil (USA)
15	Berkshire Hathaway (USA)	Apple (USA)	AT&T (USA)	HSBC Holdings (UK)
16	Gazprom (Russia)	Citigroup (UK)	Volkswagen (Germany)	Wells Fargo (USA)
17	China Construction Bank (China)	BP (UK)	HSBC Holdings (UK)	Shell Plc (Netherland)
18	Petroleo Brasileiro Petrobras (Brazil)	Chevron (USA)	Verizon Communications (USA)	PetroChina (China)
19	Total (France)	Volkswagen (Germany)	BNP Paribas (France)	UnitedHealth Group (USA)
20	Chevron (USA)	Walmart (USA)	Microsoft (USA)	Walmart (USA)

Source: compiled by the authors.

of high-value petrochemical products. Recently, there has been a trend indicated towards active development of the biotechnology business and the search for various forms of alternative energy (Saudi Aramco). Despite the wide dispersion of subsidiaries throughout the world, many important functions, such as R&D and strategic-financial management, are predominantly centralised.

The high-tech companies in the top 20 list, represented by the so-to-say, "Big Tech Trio" — Microsoft, Alphabet and Apple — are more different structurally, than those mentioned above. All the three of them are famous for investing aggressively in artificial intelligence technologies. They run a policy in common of actively acquiring start-ups, often unrelated to their current businesses, and investing heavily in R&D and innovations. Currently, Microsoft heavily and aggressively invested in the medical, pharmaceutical and gaming industries, however, it mitigated its efforts in gadgets. Although it has relatively autonomous product divisions within its structure, Microsoft is a centralised and hierarchical corporation. Apple, which owns more than a hundred subsidiaries, not only manufactures and sells a wide range of computer hardware, smartphones and the latest gadgets, but also develops its own artificial intelligence models and it is actively investing in alternative energy sectors. Only Alphabet Inc., being the creator of the world's leading search service and the owner of the fibre optic business, has a huge decentralised divisional structure based on the product principle.

Among e-commerce companies in the world top 20 retail sector giants are Amazon and traditional offline retailer Walmart. Amazon is a transnational, double-profile organisation (online retail and cloud technologies). Despite the large number of subsidiaries established on a geographical basis, it is traditional in reserving the hierarchical construction of a complex corporative structure. Walmart also has an insignificantly diversified structure, with subsidiaries in the United States and throughout the other continents.

Toyota Motor Group is the only representative of the industrial sector, which includes financial segments, machine tools, steel, textiles, construction, as well as insurance and real estate agencies. UnitedHealth Group, which was ranked 19th for the first time, represents an insignificantly diversified group of companies in health insurance and related services. Its subsidiaries are South America-based branches and the backbone of its structure is product divisions.

Finally, Berkshire Hathaway is the most diversified among the above twenty top-list giants. Insurance and railroad transport, utilities and chemicals, engineering and financial services, construction materials, clothing, footwear and alkaline batteries, trading, training and media businesses — in short, all these businesses coexist within the group enterprise. Banks and airlines are always present in the investment portfolio of Berkshire Hathaway.

The predominant majority of the top 20 list are groups of companies, which own a variety of degrees of centralisation and hierarchical structures. Despite the recent trend towards diversification, decentralisation and networking, they have a tendency toward hierarchy. In most cases, they create a "group holding" structure as a result to find a compromise between their business expansion, infiltration into new markets and the need to maintain strategic and operational control over newly founded and acquired controlled legal entities.

As a rule, large companies manage to use harmoniously similar or related businesses with high efficiency, and their stable expansion of businesses, due to the growing size and scale, currently ensures the capability to combine parts of a large whole and to manage operation of such a giant.

Domestic companies in 2024 were not included in the global rating of the Russian version of Forbes. The authors of this research work compiled a separate rating for them, which included a hundred largest companies by net profit in 2023 (*Table 3* presents top 10 of them). The analysis of consolidated IFRS financial statements, including the financial success indicators of the groups of companies allows making the proper rating methodology.

The top ten largest Russian companies include nine groups with an extensive network of subsidiar-

Table 3

Largest Russian companies by net profit in 2023

No.	Company	Net profit, in billions of Rubles	Number of subsidiaries and related (in brackets) companies*, units.	Composition of subsidiaries (related) companies
1	Rosneft	1529	16(17)	70 organisations have been liquidated, another 4 are in the process of being reorganised. Among the active ones, most of them operate within the framework of vertical integration. There are security, consulting, social infrastructure, publishing house etc
2	Sber	1508.6	8(25)	The composition is stable in conformity with the logic of expanding the range of banking and other financial products. IT and ICT companies are massively available among both subsidiaries and affiliates
3	Surgutneftegas	1322.1	14(14)	The structure is stable, diversified and focused on the sale of petroleum products. The structure includes a project company, an asset management company, consulting and mass media entities
4	Lukoil	1160.3	45(47)	The structure of horizontal (regional) and vertical integration in combination from research and development to petrochemicals and retail sales of petroleum products. It includes design, security, logistics, financial entities
5	Novatek	469.5	28(34)	The structure includes predominantly gas extraction and processing companies, pegged to gas-old fields locations. Vertical integration is prevalent, from exploration and engineering to the sale and transportation of crude oil
6	VTB	432.2	20(21)	The composition is stable and assumes relative diversification. It includes a whole variety of consultancy, property management, leasing, airport and real estate activities, factoring and IT companies
7	Sakhalin Energy	315.3	0	The new entity established in the second half of 2022. The rights and obligations of Sakhalin Energy have been transferred to it
8	Transneft	306.6	24(24)	A network of regional subsidiaries involved in operational activities, such as pipeline transportation of crude oil and petroleum products. Three subsidiaries engaged in accounting, IT, metering and automation, which indicates outsourcing of maintenance functions
9	Tatneft	286.3	63(66)	The composition of the group's companies is similar to Lukoil. Vertical integration prevailing: from R&D and geological exploration to petrochemicals and retail sales of petroleum products. Unlike Lukoil, no regional division in the structure, but it runs a greater product variety of companies: from airport operations to production of tyres and biotechnology
10	Norilsk Nickel	251.8	20(23)	A highly diversified company in mining and fuels sectors, rather of vertical integration structure. It also includes design and construction companies, airport, electrical and mechanical services, logistics, management and marketing companies

Source: compiled by the authors.

Note: Based on aggregator data Rusprofile.ru

ies and affiliates, both engaged in the mining and banking sectors, except position No. 7, which is the reformatted Sakhalin 2 project. In general, Russian groups have a wider range of diversification, especially in the mining sector. This may be the historical tradition when large holdings build a network of subsidiaries in all sectors with outward financing from headquarter. Market relations between large customers and independent contractors are not a very common tradition in Russia. Moreover, a high share of non-core companies and social blocs in groups often become a result of a compromise between big business and the State. In 2013–2014, the situation could have been determined as the consolidation with the predominance of socially important (usually unprofitable) companies and industries among the non-core assets.

The benefits of this phenomenon include the redistribution and matching of incomes in industries with different market conditions, guarantees to cover social costs and expences, etc. At the same time, there are a few drawbacks, such as, reduced motivation in a non-core company to achieve economic efficiency, difficulties in harmonising accounting policies of companies, increased transaction costs, problems of different state regulation of economic agents from many industries, complication of methods and criteria of group management efficiency.

The composition of subsidiaries of Tatneft and Lukoil allows visualising their strategic priorities and the scope of their activities. Tatneft is more focused on refining and petrochemicals, as well as on business development in Tatarstan. Lukoil has a more diversified portfolio of subsidiaries and a broader scale of operations geographically. Sberbank, the largest bank in Russia, has a high degree of centralization and a lower level of diversification. Besides, nearly all of its non-core subsidiaries are IT companies and its operational control can be characterised as total.

Consequently, domestic corporate giants have a higher level of centralisation and at the same time a higher level of diversification within the framework of integration and support of regional social infrastructure. We shall examine furthermore their nature of centralization.

DISCUSSION OF RESULTS

The current study has confirmed once again that the world-largest companies and the giant groups in the Russian Federation are complex corporate entities that have distanced themselves from a monolithic structure as their businesses grew and expanded. Nowadays they mostly operate or they are in development as holdings with a centre (parent company) and periphery (subsidiaries and related legal entities). Although in the early 2000s, most experts found out predominantly decentralised large structures and expected their modification in the form of horizontal and network formations, nowadays they identify not just a slowdown of such processes, but a certain shift towards centralisation.

To sum it up, we should like to emphasise a number of results, which we find quite important. We have affirmed that the major companies in the world are large groups of companies with a complex network of subsidiaries and affiliates, as well as with a different level of centralisation and hierarchical structures. In most cases, a holding-type group is founded as a result of a compromise between the growing business, entering new markets and the need to ensure strategic and managerial control over the legal entities created and acquired under control. Russian enterprise groups are also characterised by a high level of centralisation, despite their far more diverse businesses and legal entities.

Thus, the objective of the research has been achieved: we have come to a conclusion, that the composition is relatively constant for the largest business enterprise groups both throughout the world and in Russia and their structures are shifting from diversification and dispersion towards centralisation of management.

The authors plan to make a further research aimed to examine the specifics of this trend. Question: is the increase in centralisation a consequence of the growing risks of general global instability, or is it more so the result of the new technological possibilities for centralised control of group companies? Perhaps, this trend is a balance of influence between opportunities and risks, which is

very specific to each subsidiary. In any case, it is now clear that the complexity of groups (diversified industries, value chain structures, uneven regulatory impact, etc.) should imply the use of specific financial management models, the development of which is of paramount importance.

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State Policy in the Field of Waste Management: Effective Global Practices for Russia

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ABSTRACT

Globally, there are a number of successful practices and initiatives aimed at solving the problem of waste management and reducing its negative impact on the environment. The relevance of their application is due to the growing volume of waste accumulation, which is becoming a global environmental problem. **The aim** of the article is to identify possible economic benefits based on the analysis of the possibilities of applying global practices in the field of waste management in Russia. **Research methods:** economic and statistical analysis, comparison, generalization, synthesis, systematic approach. **The results of the study.** The article presents results of potential implementation of the "waste-free city" concept. Possible economic benefits have been identified when incinerators are put into operation in some regions, electricity is generated by incineration of waste sent to landfills, and traditional fuel is saved in the production of "green energy" at these plants. The benefits of using the reverse logistics mechanism have been determined. The introduction of reverse logistics practices encourages the solution of waste reduction tasks, sustainable competitiveness, and economic benefits. The results of effective deposit repayment programs implemented in many countries are summarized. **Scientific novelty.** Based on the results of the analysis, the authors substantiate the application of world practice in Russia. **Practical significance:** the research results can be applied to develop project activities, development strategies, and to adapt global practices to Russian realities, taking into account economic and environmental consequences, while choosing the most appropriate mechanisms to support effective waste management practices.
Keywords: waste management; international practice; closed-loop economics; incinerator; reverse logistics system; deposit system; circular economy

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INTRODUCTION

The changing geopolitical situation requires new approaches to deal with climate challenges. The major issues on the global agenda are co-operation on low-carbon development, drastic reduction of the anthropogenic impact on the climate and environmental protection. Russia is looking for new formats to implement ESG (environmental, social, governance) initiatives. ESG is a concept that enables the integration of environmental, social and governance factors into business objectives. Nowadays, the growing number of investors and regulators consider environmental sustainability as an integral part of modern businesses.

The depletion of natural resources has a significant impact on social development, and landfills pose environmental risks. Many countries are striving to transform the waste management industry to achieve economic growth while minimising environmental impact. They are implementing effective initiatives to reduce waste generation, ensure safe disposal and rationalise resource use.

LITERATURE REVIEW

The article by Chinese authors provides an overview and evaluation of the establishment of a "zero waste city" in China, it reports new results on the implementation of the "zero waste" concept and analyses the performance evaluation of the current level of solid waste management [1]. Many researchers focus on direct supply chains, however, little information about reverse supply chains was in consideration yet [2]. Some scientific articles present the reverse logistics system, identify its key processes [3–6], and its application as a strategic tool for economic benefits [7–9].

It is worth mentioning the argument in favour of importance of a deposit return mechanism for beverage and electronic packaging to solve many environmental problems [10]. The authors of one of the articles compare similar experience in Germany, Sweden and Australia [11]. Researchers also focus on the impact of waste collection and separation systems on the quality and efficiency of mechanical recycling of plastics [12].

ZERO WASTE CONCEPT

In the context of the circular economy, creating "zero cities" has become a goal for a growing number of countries and cities [13].

Many nations have achieved success in this direction. France has designed a national circular economy roadmap for 2019. Singapore has launched a master plan. Italy, the US and Japan have set the goal to achieve zero waste standards by the beginning of the 21st century. The European Union aims to ensure safe recycling of waste with priority to resource efficiency to achieve a win-win outcome for both economic development and the environment [14, 15].

China is one of the largest producers of solid waste, with reserves of approximately 60–70 billion tonnes. Over 10 billion tonnes are discarded each year and overall recycling rate is less than 55 per cent. The development of a circular economy in the People's Republic of China is focused on creating a multi-level, highly efficient recycling system [16, 17]

The waste-free city concept in China, based on international practices and innovative policies, promotes green development patterns through waste reduction and efficient resource use [18].

Incinerators make part of the waste free city concept, which involves the conversion of waste into electricity and heat. In 2023, China's electricity generation from renewable municipal waste totalled 13 GW, which is the highest indicator since 2010 and about 2 GW more than in 2022.[1] By the end of the year 2022, their daily incineration capacity reached 1 million tonnes, 3 years ahead of the target [19].

A well-proven clean energy solution are waste-to-energy technologies. They demonstrate high efficiency and are widely used in Japan, Switzerland, Finland, South Korea and the Northern Europe.

[1] URL: Statista/ https://www.statista.com/statistics/963246

Russia is also planning to build more waste-to-energy project plants. The RT-Invest Group's waste-to-energy plant put in operation in the Moscow region has become a revolutionary event for the country's energy sector and for the preservation of environment in Russia. It produces energy from non-recyclable waste, which is processed after the obligatory industrial sorting and selection of useful fractions. The thermal power plant will be able to process 700 000 tonnes of household waste and generate 520 million kWh of "green" energy per year,[2] which is enough to supply 80 000 inhabitants with electricity.[3]

Waste-to-energy plants are currently under construction in Solnechnogorsk, Naro-Fominsk and Bogorodsk districts of the Moscow Region, as well as in the Republic of Tatarstan. Five new plants with a total processing capacity of about 3.3 million tonnes of waste per year will be able to produce more than 2,200,000 MWh of "green" energy, reduce CO_2 emissions by 3.8 million tonnes per year and improve the quality of life of more than 18 million people.[4]

The new project of waste incineration to provide heat and electric power envisages the construction of two plants in Moscow and four in the Moscow region by 2029.[5] All this contributes to elimination of landfills, so it seems reasonable to complement environmental projects with rehabilitation measures of degraded land [20].

Let us determine the potential benefits of incinerating one tonne of garbage:

- production of 300 550 kWh of electric energy;
- production of 600 kWh of thermal energy (515 Gcal) [21];
- saving 0.5 tonnes of coal or 0.25 tonnes of natural gas[6];
- avoids greenhouse gas (GHG) emissions of 2–10 tonnes (in terms of CO_2). One tonne of waste emits from 0.05 to 0.15 tonnes of methane, which has a greenhouse effect more than twice that of carbon dioxide.[7]

In addition, the storage for the remaining waste after incineration is environmentally safe and requires 10–12 times less space.

Let us make a calculation of the approximate benefits of incinerators in some regions using their performance indicators:

- the plant commissioned in the Moscow region, which will be able to process 700 thousand tonnes of municipal solid waste (MSW) per year, which were left after sorting and found unsuitable for recycling, generate 520 million kWh of green energy per year (742.9 kWh per each tonne of waste incinerated).
- the plant commissioned in Kazan, which will process 550 thousand tonnes of MSW and generate 55 MW of energy; it is planned to generate 690 kWh of electricity from each tonne of waste.[8]

Let us look at the regions that, according to FinExpertiza's calculations, will generate the largest and smallest amounts of waste per capita[9] in 2023 (*Table 1*).

As it was revealed, Voronezh Oblast, Bashkortostan and Dagestan discard significantly more solid municipal waste to landfills than other regions analysed: (952 075.0 tonnes, 842 766.1 tonnes and 686 717.6 tonnes respectively). We shall use the example of calculation for a waste-to-energy plant in Moscow region to determine the approximate benefits of building high-capacity incinerators capable to process annually 700 thousand tonnes of household waste and generate 742.9 kWh of green energy per tonne of waste incinerated. The results show that in the Voronezh region

[2] URL: https://www.bigpowernews.ru/markets/document117585.phtml

[3] URL: https://neftegaz.ru/news/energy/873211

[4] URL: https://neftegaz.ru/news/energy/873211

[5] URL: https://www.vedomosti.ru/economics/articles/2019/12/15/818744

[6] URL: https://meganorm.ru/Data2/1/4293852/4293852448.pdf; URL: https://files.stroyinf.ru/Data2/1/4293784/4293784075.pdf

[7] URL: https://belfes.ru/wte/

[8] URL: https://protatarstan.ru/news/razumnoe/musor-energiia?ysclid=m65i00w1bs216306617

[9] URL: https://finexpertiza.ru/press-service/researches/2024/bolshe-musora/

the energy production will be 707 296 487.7 kWh (952 075.0 t * 742.9 kWh) (*Table 1*).

In other regions, the benefits are calculated on the basis of the capacity of the plant under construction in Tatarstan (550 thousand tonnes of solid waste per year, 690 kWh of electricity per 1 tonne).

As we mentioned earlier, burning 1 tonne of waste saves 0.5 tonnes of coal or 0.25 tonnes of natural gas. Let us use these data to estimate the benefits (*Table 2*).

The average price of steam coal in Russia was 2 400–2 600 Rubles in 2022 and for the steam coal for thermal power plants of the Far East in 2023 was 3 000–3 400 Rubles per tonne.[10]

In 2023, the price of coal on the Russian market was in average about 30 USD per ton, which is about 4 times lower than the world price (120–130 USD per tonne).[11] Accordingly, for the estimation

[10] URL: https://www.bigpowernews.ru/news/document112113

[11] URL: https://spimex.com/upload/iblock/6b2/dniqsmvg2087.pdf

Table 1

Calculation of the volume of electricity generation from waste intended for disposal in 2023 (kWh)

Region	Share of disposed MSW, including treated (sorted) MSW in the total mass of generated MSW (%)	Population (persons)	MSW per capita (in Kg)	MSW sent for disposal (tonnes)	Electricity generated (kWh)
Voronezh region	96.0	2 279 349.0	435.1	952 075.0	707 296 487.7
Bashkortostan Republic	86.8	4 070 980.0	238.5	842 766.1	626 090 963.7
Dagestan	100.0	3 221 002.0	213.2	686 717.6	510 162 524.7
Republic of Adygea	91.7	499 288.0	605.8	277 363.8	191 381 001.8
Novgorod region	91.8	573 687.0	501.7	264 217.6	182 310 164.0
Yamalo-Nenets Autonomous Okrug	98.2	514 174.0	453.5	228 980.7	157 996 687.6
Sakhalin Region	98.6	459 063.0	430.1	194 678.8	134 328,368,.1
Republic of Buryatia	99.8	973 275.0	127.2	123 553.0	85 251,555.4
Mari El	99.0	671 088.0	217.6	144 568.5	99 752,238.3

Source: compiled by the authors.

Table 2

Calculation of savings of non-renewable natural resources for 2023

Region	Amount of MSW sent for disposal (tonnes)	Coal savings (tonnes)	Natural gas savings (tonnes)	Coal savings (mln. Rubles)	Whole sale prices of gas (Rubles / 1000 m^3)	Natural gas savings (thousand m^3)	Natural gas savings (mln. Rubles)
Voronezh region	952 075.0	476 037.5	238 018.7	1 428.1	5.751	297 523.4	1 711.1
Bashkortostan Republic	842 766.1	421 383.1	210 691.5	1 264.1	5.002	263 364.4	1 317.3
Republic of Adygea	277 363.8	138 681.9	69 340.9	416.0	5.873	86 676.2	509.0
Novgorod region	264 217.6	132 108.8	66 054.4	396.3	5.555	82 568.0	458.7
Amur Region	308 619.8	154 309.9	77 155.0	462.9	4235	96 443.7	408.4
Kaliningrad region	458 469.4	229 234.7	114 617.3	687.7	5.582	143 271.7	799.7
Yamalo-Nenets Autonomous Okrug	228 980.7	114 490.4	57 245.2	343.5	3.154	71 556.5	225.7
Sakhalin Region	194 678.8	97 339.4	48 669.7	292.0	3788	60 837.1	230.5
Dagestan	686 717.6	343 358.8	171 679.4	1 030.1	5.873	214 599.3	1 260.3
Mari El	144 568.5	72 284.2	36 142.1	216.9	5.168	45177.6	233.5

Source: compiled by the authors

of savings we will use the indicator 3 000 Rubles per tonne.

One tonne of natural gas contains approximately 1 250 cubic meters of gas (density 0.8 kg per cub/m). To calculate savings, we will take into account the wholesale prices of gas (RUB/1 000 cub/m) in accordance with the Ordinances of the Federal Antimonopoly Service of Russia 910/23[12] dated 28.11.2023, 816/22[13] dated 16.11.2022 and 818/22[14] dated 16.11.2022 (*Table 2*).

The results of the analysis indicate that incineration of the municipal solid waste sent to the plants instead of landfills will lead to the following resource savings: 476 037.5 tonnes of coal worth 1 428.1 million Rubles and 238 018.7 tonnes of

[12] URL: http://publication.pravo.gov.ru/document/0001202312010032

[13] URL: http://publication.pravo.gov.ru/document/0001202212010069

[14] URL: http://publication.pravo.gov.ru/document/0001202212010058

natural gas worth 1 711.1 million Rubles are in the Voronezh Region; 421 383.1 tonnes of coal worth 1 264.1 million and 210 691.5 tonnes of natural gas worth 1317.3 million Rubles are in the Republic of Bashkortostan; 229 234.7 tonnes of coal worth 687.7 million Rubles and 114 617.3 tonnes of natural gas worth 799.7 million Rubles are in Kaliningrad Oblast.

Despite the expected benefits, it is worth noting, that the capacity of some incinerators will be used not in full 100 per cent, so it is possible to consider bringing additionally more solid municipal waste for incineration from some neighbouring regions. The choice of the most appropriate technology depends on the capital investment and the capacity of the plant.

Since legislative changes back up a closed-loop economy increasingly, it is reasonable to envisage a growing number of waste-to-energy plants. The implementation of the waste-free city concept in Russia contributes to more waste recycling, economic benefits and the prevention of negative environmental impacts.

PRACTICAL APPLICATION OF REVERSE LOGISTICS

Reverse logistics is a strategy with a great potential to promote sustainable development [22]. It plays an important role for the adoption and implementation of the circular economy concept in supply chains. Reverse logistics was developed in the USA, Canada, China, Germany, India and other countries as an essential instrument within the framework of the growing e-commerce and technological innovation. It contributes to developing strategies for an effective take-back and recycling policy, when the priority is set for recycling, resales at reduced prices, donations and the establishing of reserves for recycling.

The concept of reverse logistics ensures revenues for companies and the implementation of its tools in projects could be a potential solution to waste management problems and contribute to the reduction of CO_2 emissions [23].

The reverse logistics process is developing worldwide, wherever new systems being developed to improve it [24]. Currently, more and more research has been conducted in this area. Many scientists support the introduction of Industry 4.0 principles [25, 26], which can accelerate the development of a circular economy with implementation of modern production technologies and waste use.

Sophistication and innovations in reverse logistics contribute to establishment of the circular economy, by means of supporting sustainable practices and minimising waste. In some countries, such programmes and roadmaps have become significantly popular. Russian model of economy based on the export of raw materials is unsustainable, and one of the reasons for this is the social and environmental problems caused by the high growth of waste [27].

In this context, the following aspects should be under consideration:

- the volume of the global reverse logistics market was amounted to $ 1.07 trillion USD in 2023 and 1.22 trillion USD in 2024, by the year of 2033, it is expected to grow by around $ 3.68 trillion USD, which is 13.1 per cent higher than in 2024;
- the Asia-Pacific market contributed over 52.14 per cent of the revenue in 2023 and was valued at $ 560 billion, moreover, by 2033, it is expected to be around $ 1.970 billion;
- Middle East and Africa market will grow at a compound annual growth rate of 13 per cent from 2024 to 2033;
- E-commerce is accounted for more than 56 per cent of the segment's revenue share in 2023;
- the share of repairable returns is expected to grow at a compound annual growth rate of 6 per cent from 2024 to 2033.[15]

The expansion of e-commerce is the driving force for the growth of reverse logistics. The volume of e-waste is increasing: the global pro-

[15] URL: https://www.precedenceresearch.com/reverse-logistics-market

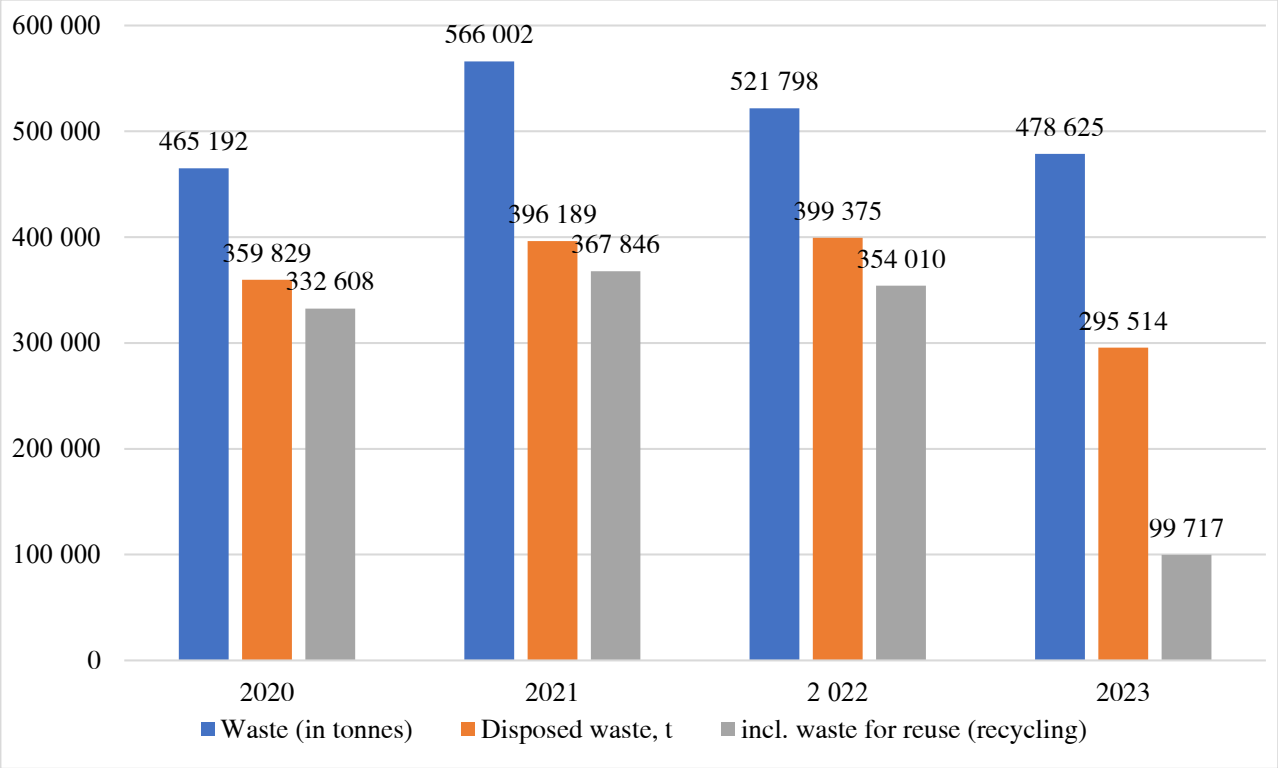

Fig. 1. **Dynamics of the movement of electronic waste (t)**

Source: compiled by the authors on the basis of: URL: https://rpn.gov.ru

duction in 2022 will be 62 million tonnes (7.8 kg per capita); 22.3% (13.8 million tonnes) will be reported as properly recycled.[16] The volumes of electronic waste is expected to reach 74 million tonnes by 2030.[17]

The analyses of research and analytical data indicate that the implementation of reverse logistics mechanisms contribute to the following:

- they bring down costs, reduce e-waste, increase profitability through product recovery;
- they maximise profits (through repair, resale, reuse) which otherwise might have been lost;
- they recover and recycle products (e-waste producers are responsible and obliged to process recycling).

The authors conducted an analysis for the period 2020–2023 (*Fig. 1*), which indicates that the volume of e-waste collection in Russia has increased.

Figure 2 shows the dynamics of waste generation and waste recovery by type of "Manufacturing" economic activity: production of computers, electronic and optical hardware). With regards to this type, the volume of waste recovery is decreasing.

Thus, the application of reverse logistics will contribute to the growth of waste recovery and recycling. At the same time, the following aspects should be taken in consideration.

1. It is possible to recover critical materials and metals from waste, but this requires investments and equipment. For example, the content of gold, silver and palladium in electronic components, cable contacts, microcircuits range from 179.86 to 3694.51 mg/kg, from 809.0 to 12320.51 mg/kg and from 96.25 to 117.49 mg/kg respectively. The

[16] URL: https://www.genevaenvironmentnetwork.org/resources/updates/the-growing-environmental-risks-of-e-waste/

[17] URL: https://forbes-ru.turbopages.org/forbes.ru/s/mneniya/476085-zoloto-iz-musora-perevernet-li-novaa-tehnologia-pererabotku-othodov-elektroniki

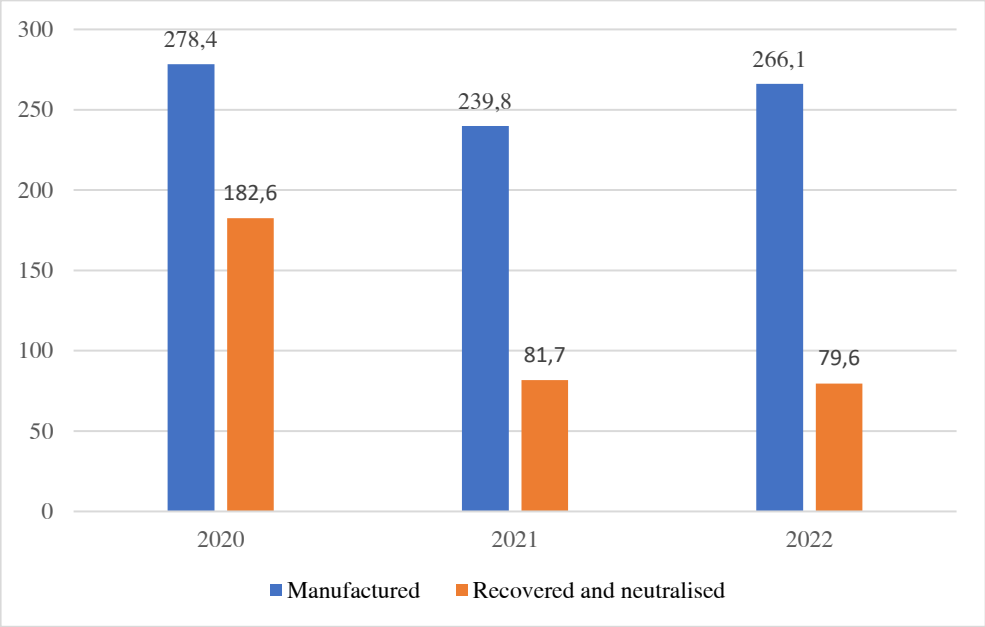

Fig. 2. **The dynamics of waste generation and disposal by type of economic activity "Manufacturing" (production of computers, electronic and optical products – in tonnes).**

Source: compiled by the authors on the basis of data from the Federal State Statistics Service. URL: https://rosstat.gov.ru/storage/mediabank/oxr_bul_2023.pdf

economic value of recycled precious metals in 1 tonne of e-waste is up to 2 292.94 USD, with a gold content of 98 per cent [28]. Extracting metals from e-waste is environmentally friendly and 13 times less expensive than mining. 85–90 per cent of the materials used to produce refrigerators can be recycled.[18]

2. Electronics manufacturing and e-waste disposal generate high greenhouse gas emissions. Recycling products reduces the carbon footprint and is beneficial to avoid greenhouse gas emissions.

3. Analytical studies, application of data analysis, adequate tracking technologies and introduction of management systems of supply chains will help to improve understanding of needs [29]. Manufacturers can develop a system of target indicators to evaluate the reverse logistics policies.

The following measures are recommended to develop the introduction of the reverse logistics mechanism in Russia:

- improving legislation;
- informing the society about the importance of waste recycling and recovery;
- developing technology for effective reverse logistics management;
- introducing environmentally friendly practices;
- investing in infrastructure, developing recycling technologies.

The authorities improve legislation in the area of waste management and expand the ecological education activities implemented within the framework of State programmes. Adoption of legislative and regulatory documents will not require additional expenditure from the budget. Private investors are able to invest in infrastructure, development of recycling technologies within the framework of public-private partnership subsidies and privileges from the budget of the National Project "Ecological Wellbeing" for 2025–2030. It is planned to allocate about 600 billion Rubles for environmental projects by 2030 and for programmes to finance lending

[18] URL: https://www.mckinsey.com/capabilities/sustainability/our-insights/sustainability-blog/implementing-decarbonization-what-consumer-companies-should-know

to small and medium-sized enterprises by 2025 it is planned to allocate 57.6 billion Rubles in 2025 and about 238.0 billion Rubles in 2030.[19]

Thus, implementing the above mentioned measures: economic benefits, sustainable competition, reducing waste and greenhouse gas emissions etc. encourage Russian companies to adopt reverse logistics.

DEPOSIT RETURN SCHEME

Resource management and circular economy policies in the EU are constantly improving. Germany has a highly efficient deposit-refund system (DRS): thanks to a high deposit value and a convenient network of return points, DRS system provides a record 98 per cent return rate for a single-use drinks packaging. Germany was the first country in Europe to introduce the deposit-refund system in 2003, which is evaluated the most successful in the world[20] with approximately 3 billion disposable containers[21] discarded each year. This policy increases the amount and a whole variety of recycled plastic raw materials, including for the production of various containers. It also promotes effectively the development of a circular economy and helps to minimise waste.

The authors present here the following global statistics in the analysed area.

In 2023:

- In the UK, 70 per cent of PET-bottles[22] were processes for recycling, in Sweden the amount was 90–95 per cent;
- In the USA, 890,000 tonnes of bottles were collected, 2.7 per cent more than in 2022, with a recycling rate of 33 per cent[23];
- Germany and Finland have high rates of collection of PET bottles: 98 and 97 per cent respectively[24];
- In Russia, the recycling rate is up to 25 per cent[25].

In 2024:

- Belgium and the countries of the Arabian Peninsula were the leaders in terms of plastic waste per capita (147.7 kg per capita);
- Russia had 33 kg of plastic per capita.[26]

Our country has adopted The Ecoplatform Programme to recycle plastic bottles and aluminium cans: over 13 million of them were collected in 2022 and more than 19 million in 2023.

Thus, thanks to the deposit-refund system, which has proven to be effective, countries have achieved a high level of collection and reuse of plastic bottles.

However, in Russia the current economic mechanisms do not fully generate the recovery of secondary resources, including the lack of incentives for recycling costs [30]. The introduction of efficient deposit-refund system will contribute to the reduction of plastic waste, increase collection and recycling, save energy and raw materials for the production of new containers.

It is worth noting that complete transition to a closed-cycle economy practically solves the problem of waste recycling. Capital investments in Russia are channeled to put in operation additional capacities: incinerator plants and modernised landfills, but domestic recycling rates are still lower than in the countries, which adopted earlier the concept of a closed loop economy. Besides, the current tariff system does not adequately stimulate the use of environmentally friendly methods of waste management: the environmental fees are 3–4 times lower than the cost of delivery of PET bottles to the recycler [31].

[19] URL: https://digital.gov.ru/ru/events/53021/; URL: https://rlw.gov.ru/press/document/19261

[20] URL: https://www.tomra.com/en/reverse-vending/media-center/feature-articles

[21] URL: https://www.statista.com/statistics/1316967/pet-collection-rates-by-country-europe/

[22] PET bottles are plastic containers of various colours, volumes and shapes for all purposes.

[23] URL: https://www.jdsupra.com/legalnews/2023-u-s-pet-bottle-recycling-national-6916540 products/Demo

[24] URL: https://www.statista.com/statistics/1316967/pet-collection-rates-by-country-europe/

[25] URL: https://drgroup.ru/components/com_jshopping/files/demo_.

[26] URL: https://plasticovershoot.earth/wp-content/uploads/2024/04/EA_POD.pdf

It is also worth noting, that promotion of "environmental awareness" in the society is a very important factor. This applies not only to separate waste collection. From 2019, the environmental fees raised for producers of plastic packaging allow them to inform consumers on the amount of the pollution charges about it in a separate space on the labels and save on environmental payments [30].

Although the completion of the circular economy is developing gradually, some industries have already made significant progress by means of introducing related initiatives and activities. The development of the circular economy will require radical changes, breakthrough innovation and unprecedented collaboration between countries, industry leaders, stakeholders, researchers and consumers.

CONCLUSIONS

In conclusion, it is worth noting, that the given article proposes to implement in Russia an effective international experience in terms of introducing the "city without waste" concept. The concept is based on a new model of urban development and aimed at reducing the amount of solid waste, safe disposal with minimal environmental impact, efficient use of resources, which will contribute to the formation of "green" models of development.

The authors have identified economic benefits from the possible commissioning of incineration plants in some regions of Russia and the generation of electricity from the incineration of waste from landfills.

The research work also demonstrates that the mechanisms of reverse logistics become an integral part of supply chain management: it can help companies reduce storage and distribution costs, as well as ensure a payback of the economic benefits related to returned products. Reverse logistics has become particularly important with the development of e-commerce. It contributes to the growth of e-waste recycling. The concept requires the development of new regulatory tools, the formation of normative and legal acts.

The article also provides recommendations for the implementation of the deposit return system (DRS) in Russia, aimed at promoting a closed-loop economy and reducing waste generation. As practice indicates, deposit return system has become effective and is widely popular in many countries, providing financial incentives for the return of used containers to be recycled or reused. In this era of developing new ways of managing waste, deposit return system is regarded as a good choice for more structured plastics recycling.

Thus, the implementation of successful global practices in Russia, such as the "city without waste" concept, reverse logistics mechanisms and deposit return systems will contribute to the development of a circular economy, as they all aim to reduce the environmental impact of production and consumption by extending the life cycle of products and materials and fulfilling efficient recycling methods.

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