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Intellectualization of Industrial Production as a Factor in Achieving Technological Sovereignty: Essence and Principles

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ABSTRACT

Relevance. In the context of the industry's rapid digital transformation, Intellectualization is becoming a key factor in improving enterprises' competitiveness and technological sovereignty. **Purpose.** This article unveils the essence of Intellectualization, which involves transitioning from the mere mechanical use of information to the intelligent, creative management of production processes through artificial intelligence and big data analysis. The eight principles of Intellectualization, which are based on national strategies and the practical experience of AI implementation in the Russian industry, are presented. **Methods.** These principles form the methodological and strategic basis for the standardisation, safety, and effective application of intellectual technologies. Particular focus is given to intelligent information systems and smart manufacturing technologies, which promote the flexibility, efficiency, and sustainable development of enterprises in the Industry 4.0. **The scientific novelty** of the research lies in its complex approach to developing intellectualization principles that take into account the specific characteristics of individual industries. **The results** of this study lay the groundwork for further research and practical solutions aimed at modernising industrial production and achieving national digital economy goals. This article will be of interest to specialists in industrial management, digital technologies, and innovative development.

Keywords: industrial Intellectualization; artificial intelligence; digital transformation; technological sovereignty; smart manufacturing

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INTRODUCTION

Intellectualization is becoming a defining condition and driving force for the development of modern industrial enterprises. Its necessity is the cause of globalization processes that transform the economic environment and the requirements for the competitiveness of enterprises. There are the following principal factors, which stimulate the Intellectualization of industry: accelerated innovative progress, the growth of the share of intellectual labor in generation of economic products, predominance of information flows in production processes, and strengthening of the role of intellectual resources, which determine the innovative potential at the national and regional levels. These tendencies are the result of the information revolution due to the shift in priority in favor of human capital [1].

Intellectualization of industry is closely related to developing information technologies, particularly, to building self-learning and self-reproducing systems that use knowledge bases to generate algorithms for solving applied problems, in view of specific needs.

The industrial sector has a range of advantages that enables to implement intelligent technologies, including high stability of technological processes, a significant amount of data for machine learning and systematic modernisation of production systems. A number of companies operate by means of determining its organizational principle of continuous upgrading at the institutional level [2].

Intellectual industrial production represents an automated system integrating physical, digital and biological components and this is regarded a national priority. Its development is aimed at modernising enterprises in accordance with the concept of Industry 4.0, improving the quality and innovation of products, which ensures sustainable competitive advantages.

The revised "Strategy for the Digital Transformation of the Manufacturing Industry until 2030"[1] has singled out the following priority areas: "Smart Production", "Digital Engineering", "Products of the Future", "Technological Independence" and "Governmental Backing of Intellectual Activities". In 2024–2026, the financing for the implementation the "Smart Production" project amounted to 8.5 billion Rubles primarily from extra-budgetary sources. Its key objectives include optimising resource productivity, introducing predictive analytics and the Industrial Internet of Things, developing domestic software and platforms, and professional retraining of personnel.

Smart production technologies ensure flexible and efficient production processes and they allow for personalised management based on real-time data analysis.

The current stage of digital transformation in industry is defined by proactive introduction of artificial intelligence technologies, which requires the simultaneous involvement of all industries for a well-balanced economic advancement [3]. This will enable to radically improve the quality of products, reduce costs and ensure rapid adaptation to market changes, and concurrently strengthening the positions of enterprises in the domestic and foreign markets and contributing to the achievement of technological sovereignty [4, 5].

Currently, the nature of practical study of the Intellectualization of industrial production is of transdisciplinary character, as it requires a combination of engineering sciences, economics, information technology and management. Thus, this field opens up vast opportunities for a new research. Consequently, R.V. Morozov and I.S. Belyasov in their article contemplate Intellectualization as a comprehensive upgrading of production processes, including technology, personnel, equipment and products [1]. Concurrently, it indicates that Intellectualization leads to the establishing an intellectual space and an increase in product quality, and it also provides sustainable competitive advantages. M.D. Fufaev points out the influence of digital technologies on the improvement of innovation activities in industry, in particular in Russia, and emphasises that digital transformation contributes to the optimisation of processes and an increase in productivity [6].

[1] URL: http://publication.pravo.gov.ru/document/0001202311090050

A few other scientific studies indicate that the key areas of Intellectualization of industrial production lead to the introduction of digital technologies, artificial intelligence, predictive analysis systems and intelligent algorithms. All of them contribute to increasing the efficiency, safety and competitiveness of industrial enterprises, especially in the oil and gas sector. The article by O.I. Shiryaeva and N.S. Sarsenbaev gives a methodology for the Intellectualization of oil and gas production. As a case in point, the article provides the examples of employment of a CENTUM VP distributed system and global search optimisation algorithms for the synthesis of regulators, which reduces costs and improves the quality of process control. [7]

The need to solve problems related to the achievement of technological sovereignty requires specifying the essence of Intellectualization and developing principles for the use of artificial intelligence in industry, which is determined by some of the following factors identified by means of analysis of modern scientific literature:

- intellectualization of industrial production is a comprehensive renewal of production processes (including technologies, personnel, equipment and products), which enables to establish a single intellectual space and an increase in product quality, ensuring sustainable competitive advantages;
- understanding the essence of Intellectualization allows to shift from traditional mechanistic systems to those integrating digital technologies and artificial intelligence, which significantly increases the efficiency, safety and innovative potential of enterprises;
- intellectualization is not just the introduction of new technologies, but a special work method of activities, where the key role is played by the cognitive use of information, which contributes to the development of a new, dynamic-and-sustainable knowledge-based economy.

Thus, the given research is focused on defining the essence of Intellectualization in terms of minimising or counteracting threats to the technological development of industrial production, as well as to identifying the principles of using artificial intelligence in industry as one of the factors of technological sovereignty.

THE CONCEPT AND ESSENCE OF INTELLECTUALIZATION OF INDUSTRIAL PRODUCTION

The conceptualisation of Intellectualization of industrial production plays an important role in assessing the achievement of technological sovereignty. Critical analysis of strategic documents reveal that, despite their importance for the national economy, insufficient attention is rendered to the development of industrial sectors: the latter is characterised by disproportion and pronounced structural disparity. Therefore, it is necessary to take a differentiated approach for deployment of artificial intelligence in this sector, which is also necessary to take into account the industry specifics and, in this regard, envisage the differences in the levels and types of technological threats.

Intellectualization of industrial production is the process of introducing AI and digital technologies, such as a set of solutions that imitate human cognitive functions, into manufacturing sectors to ensure technological independence and increase the competitiveness of the national economy.

The essence of Intellectualization lies in the transition from the mechanical use of information to intelligent and creative production management, which allows establishing a single space for making management decisions based on artificial intelligence and big data analysis. Intellectualization transforms industry and makes it more autonomous and efficient. This is not just a trend. It is an essential requirement in the context of global digitalisation and growing competition: companies implementing these technologies gain a strategic advantage.

However, in order to ensure the Intellectualization process effectively, it is necessary to define the principles of using artificial intelligence in industrial production: namely, the rules, approaches and limitations.

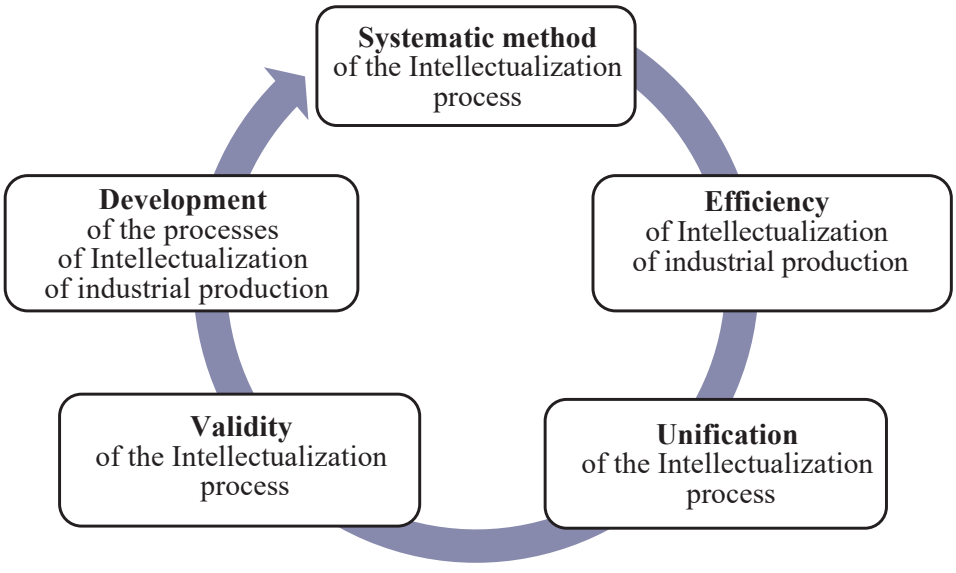

Fig. 1. **Prerequisites for Determining the Principles of Intellectualization of Industrial Production**

Source: compiled by the authors.

BASIC PRINCIPLES OF USING ARTIFICIAL INTELLIGENCE

Defining the principles of Intellectualization of production processes will contribute to the systematization of knowledge on AI technologies in industrial production, their unification for different industries, as well as progress in achievement of technological sovereignty (*Fig. 1*).

The development of principles for the utilisation of AI in industry as a factor in Russia's technological sovereignty is based on key documents which formulate the regulatory and conceptual basis for its ethical and secure use: the Strategy for Scientific and Technological Development of the Russian Federation,[2] the State Program "Development of Industry and Increasing its Competitiveness",[3] as well as the National Strategy for the Development of Artificial Intelligence for the Period up to 2030.[4]

The last of these documents defines eleven basic principles for the use of AI (illustrated in the *Fig. 2*), which should be regarded as basic ones.

Back in 2019, seven initial principles were formulated, and the rest were included in the text of Strategy in 2024. They are all based on the idea that such technologies should make people's lives easier and better, rather than create new threats.

The first principle concerns ensuring the citizens' rights and freedoms in accordance with Russian and international legislation, as well as obtaining their ability to successfully adapt to digital technologies. The second principle ensures the prohibition of the use of AI for the purpose of bringing harm for people and companies and minimising the risks regarding the leakage of personal data or disclosure of classified information. The third one implies the openness and accessibility of AI, equal access for users to the algorithms used in its work. The fourth, quite a separate principle, deals with technological sovereignty, which can be achieved by relying on domestic artificial intelligence technologies. The fifth one assumes a close relationship between developments in the field of artificial intelligence and their implementation in the real sector of the Russian economy. The sixth principle focuses on the use of AI technologies primarily in the scientific and technical sphere and other key sectors for the development of the state. The seventh principle stipulates preventing monopolization in the field

[2] URL: http://www.kremlin.ru/acts/bank/50358
[3] URL: http://government.ru/rugovclassifier/862/events/
[4] URL: http://www.kremlin.ru/acts/bank/44731

1. Protection of human rights and freedoms
2. Security
3. Transparency
4. Technological sovereignty
5. Integrity of the innovation cycle
6. Most effective use of AI technologies
7. Support for competition
8. Openness and accessibility
9. Continuity
10. Safety
11. Reliability of source data

Fig. 2. **Principles of Development and Implementation of AI in Accordance With the Strategy**

Source: compiled by the authors.

of AI, ensuring fair competition between organizations using such technologies.

Finally, four more principles, which were introduced into the National Strategy last year. The eighth principle determines a ban to restrict access of industry organizations to AI technologies. The ninth principle implies a gradual incorporating of these technologies for government bodies. The tenth one is their legal protection, and the eleventh principle ensures the reliability of AI-generated data used in model training.

These principles are close to international approaches, however, unlike the latter, they place greater emphasis on sovereignty, and their advantages include the fact that they are aimed at:

- strengthening national security, increasing the competitiveness of the economy and improving the quality of life of the population;
- stimulating domestic AI technologies, which contributes to the country's sovereignty in this area and reducing dependence on foreign digital solutions;
- increasing the level of digital literacy and informing the population about the specifics of artificial intelligence in order to train qualified AI specialists and users;
- creating a foundation for a regulatory framework of documents governing relations which arise in the process of using AI.

However, the mentioned principles have their shortcomings too. Thus, the scientific community has developed a perception, that by the time these principles were defined, Russia's position was not fully reckoned with the global digital space, which may complicate the implementation of the Strategy [8]. However, one of the disadvantages stems from the advantages: despite the fact that the principles facilitate increasing the level of digital literacy of the population and its awareness of the benefits of artificial intelligence, open accessibility to these technologies can also lead to an increasing digital gap as well as to social and economic differentiation.[5]

In addition, scientific researchers raise the issue of the lack of special legislation, which comprehensively regulate AI technologies [9]. Furthermore, although the security principle envisages that violation of confidentiality of personal data is inadmissible, in reality, artificial intelligence can also provide false information, which poses a threat to information security and reduces confidence among AI users [10].

Potential challenges are innate in the principle, which formulates the technological sovereignty and competitiveness of the country should depend on the development of domestic software and

[5] URL: https://unesdoc.unesco.org/ark:/48223/pf0000380455_rus

hardware systems. This is absolutely a fair statement, but so far, Russia faces sanction limitations related to resources and competencies, which makes its implementation complicated.

Some other disadvantages also include the abstract formulations of some principles, which sound unspecified, without clarifying existing problems and apt measures to solve them. This applies, for example, to the principle of transparency, which provides for equal access of users to AI algorithms, which criteria still do not exists yet.

Thus, the National Strategy can be implemented as a core for developing principles for the Intellectualization of industrial production, however, at the same time it is necessary to take into account the aforementioned potential challenges.

AI technologies display immense potential for their application in industrial production and encompass a broad spectrum of tasks, including:

- automation of production lines, which allow for acceleration and simplification of routine operations;
- projection of demand and optimisation of logistics chains;
- improving product quality by means of analyzing Big Data and preliminarily identifying defects in manufactured products;
- maintenance of equipment, which contributes to preventing malfunctions and reducing downtime.

The principal spheres of AI application in industrial production are illustrated in the *Fig. 3*.

AI technologies contribute to the following areas:

- Improving the processes of planning, projecting and management decision-making in production. For example, it can be used to forecast failures of equipment and carry out preventive maintenance, consequently reducing the risk of downtime.
- Automating routine operations, which helps employees of manufacturing enterprises to avoid monotonous work. The application of autonomous smart machines, robotic systems

Manufacturing	Mining	Supply of electric power, gas and steam
• Improving product quality and reducing production costs by meas of modeling parameters of product • Automating and optimizing of production processes by means of reducing production errors • Minimiing the influence of the human factor • Effective projection of demand	• Optimizing exploration and recovery of reserves based on geophysical data analysis • Enhancing the efficiency and safety of the production process • Preventing downtime of equipment and repairing by means of preventive maintenance	• Reduction of time and costs for design and construction of facilities by means of analyzing data related to conditions of construction sites and experience of previous projects history • Optimization of repairing by means of predictive maintenance of equipment • Optimization of operations management of energy system

Fig. 3. **Directions for the Use of AI Technologies in Industrial Production**

Source: compiled by the authors on the basis of the following: URL: https://apr.moscow/content/data; https://ivo.garant.ru/#/document/72892976/paragraph/1:0

and logistics management systems enhances labor productivity.

• Ensuring the safety of workers. AI-based systems can forecast potential risks and prevent emergency situations, reducing human involvement in hazardous processes and mitigating threats to life and health.

• Interacting with customers, increasing their loyalty by means of personalised offers and recommendations.

Thus, AI technologies become a universal instrument that becomes valuable in all areas of activity for enterprises; they create conditions for enhanced efficiency and broaden the soil for new opportunities. This is particularly essential for the industrial sector, where AI can radically transform key industrial processes.

PRINCIPLES OF INTELLECTUALIZATION OF INDUSTRIAL PRODUCTION AS A FACTOR IN ACHIEVING TECHNOLOGICAL SOVEREIGNTY

During the developing principles of Intellectualization of industrial production one should take into account the specifics of the implementation of artificial intelligence technologies in industry,

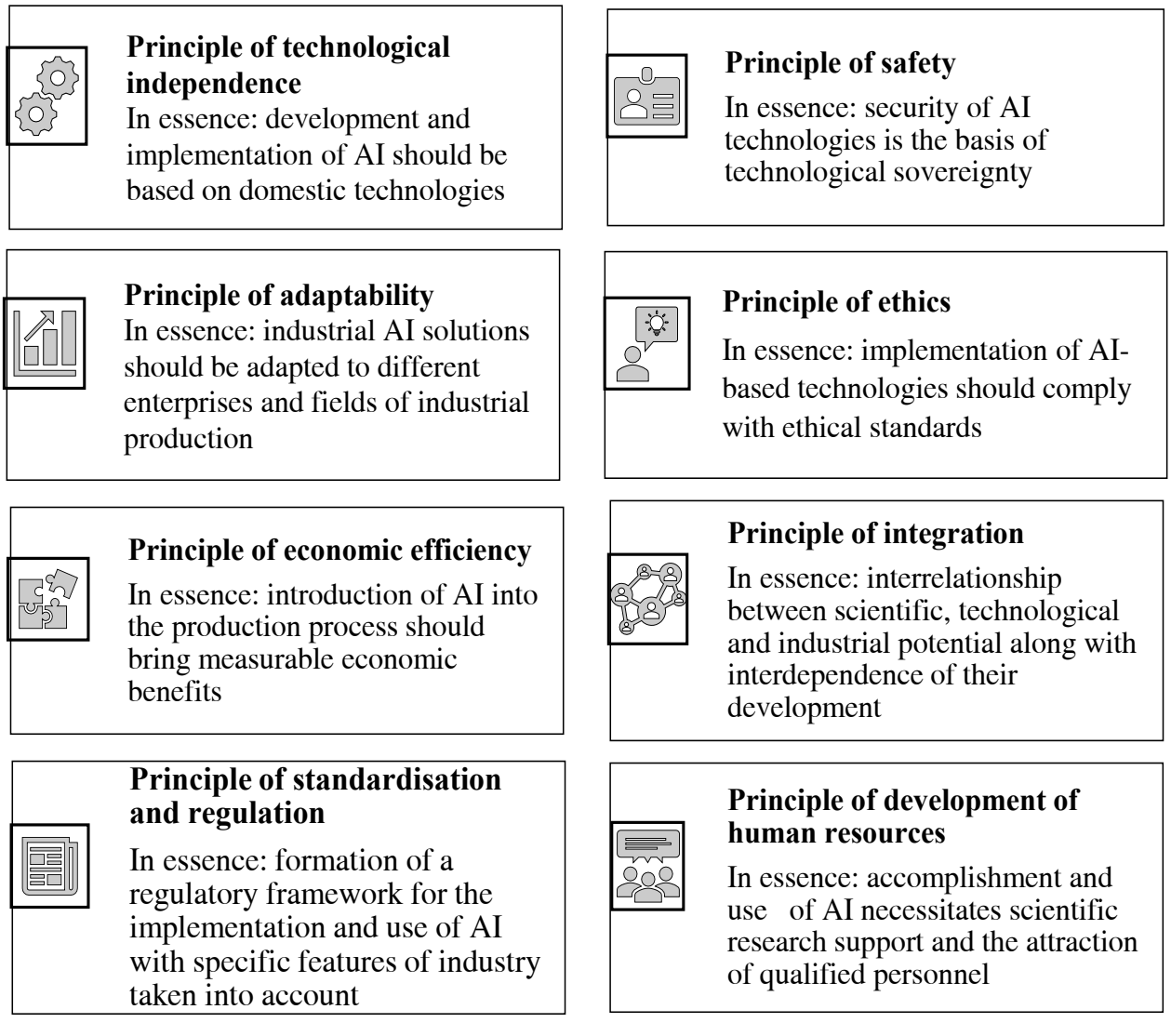

Fig. 4. **Principles of Intellectualization of Industrial Production as a Factor in Ensuring Technological Sovereignty**

Source: compiled by the authors.

as well as the characteristics of different industries. In essence, an integrated approach should be used, including eight principles (*Fig. 4*).

The principle of technological independence is established in the Concept for the Development of Regulation of Relations in the Sphere of Artificial Intelligence and Robotics Technologies for the Time Period up to Year of 2024.[6] It is also in compliance with the Strategy for Scientific and Technological Development of the Russian Federation and the State Program "Development of Industry and Enhancing its Competitiveness".

It has become a key element of technological sovereignty and it implies the introduction and control of AI technologies in the industrial sector without indispensable dependence on foreign solutions, platforms or data.

Adherence to **the Principle of Security** implies protection of AI technologies from external interference by monitoring stability of industrial systems.

The implementation of **the Principle of Adaptability** in practice includes the design of AI systems in view of the specific aspects of various enterprises and industries, as well as their technological, organizational and economic features. This is particularly essential in the context of structural disparity in industry, when fields of industry are at different levels of digitalization, automation, and readiness for the implementation of AI (according to 2020 data, the share of AI is 5.5 per cent in the manufacturing industry and only 3.4 per cent in the extractive industry [11].

This principle is in conformity with the National Strategy for the Development of Artificial Intelligence for the Period up to 2030, as well as with the Strategy for Scientific and Technological Development of the Russian Federation. It can be implemented by means of differentiated regulation of AI technologies in industries with different levels of development. Adaptability ensures scalability, integration into existing processes (compatibility with various production systems), flexibility of tuning systems (the ability to meet certain technological requirements) and resistance to changes (adaptability to new circumstances, for example, to a change of suppliers or restrictions related to introduction of sanctions).

The principle of ethics rests on a human-centered approach to the use of Artificial Intelligence, laid down in the National Strategy for the Development of Artificial Intelligence for the Period up to the year of 2030. It guarantees that AI technologies do not bring any harm for human being, society or environment, protect the rights and freedoms of citizens, contribute to the development of the national economy, and it ensures not only compliance with moral standards in industrial AI solutions, but also strengthens technological sovereignty by building trust in national developments.

The principle of economic efficiency implies ensuring measurable economic benefits: reducing costs, increasing productivity, improving quality of product, reducing risks, which altogether contribute to growing profit and competitiveness of enterprises. This is not only related to technological independence, but also economic justification of investments in digitalisation and innovations.

In Russia, practically, unified methodology still does not exists for assessing the economic efficiency of AI in industry, despite the fact, that several regulatory and strategic documents highlight the requirement to put such methodology into effect.

This indicator can be regarded as one of the criteria in the decision-making process of the implementation of artificial intelligence in production processes. Firstly, since investments in AI technologies require considerable costs, so logically, they will be inappropriate without confirmation of economic benefits. Secondly, justification of economic effectiveness allows minimising risks and enhancing returns, which is also important for industrial safety and competitiveness. Thirdly, it contributes to the efficient resource management and the achievement of the state's strategic objectives aimed at the digitalization of

[6] URL: https://www.garant.ru/products/ipo/prime/doc/74460628/#review

production and technological independence. Consequently, the principle of economic efficiency of introducing AI into industry requires that each project should be supported by an assessment of economic benefits.

The principle of integration rests on a close relationship and interdependence of scientific, technological and industrial potentials, which is particularly essential in the context of the Intellectualization of industrial production. Its substance lies in ensuring a single integrated innovation cycle that involves all stages: starting from fundamental scientific research and development up to their effective implementation in the real sector of the economy.

The given principle implies effective interaction and coordination between the scientific community, developers and enterprises. It also takes into account the provisions of the Concept for the Development of Regulation of Relations in the Sphere of Artificial Intelligence and Robotics Technologies for the Time-Period up to the Year of 2024 and the National Strategy for the Development of Artificial Intelligence for the Time-Period up to the Year of 2030.

The integration of scientific, technological and industrial potentials in the implementation of artificial intelligence makes it possible to reduce the time-period between development and implementation. This contributes to the acceleration of technological progress, enhances the competitiveness of enterprises and the efficiency of production thanks to its Intellectualization. Regulatory documents accentuate this principle as a strategic priority, with an emphasis on the coordinated development of all three components, the interrelation of which contributes to achieving independence in the field of high-priority technologies.

The principle of standardisation and regulation in the context of the Intellectualization of industrial production is based on the necessity to build a regulatory framework that would take into account the specific features of various industries. Thus, the Prospective Standardisation Program for the Priority Area of "Artificial Intelligence" for the years of 2021–2024[7] included the development of more than 100 national standards covering general and industry-specific requirements for AI technologies.

There exist some standards in the areas of "Artificial Intelligence" and "Technological Readiness". They have been developed and upgraded for taking into account some specific features of various industries. For example, the standards in the machine tool industry imply the discrete nature of production, dependence on component suppliers and a relatively low level of digital development of enterprises. Thus, the principle of standardisation and regulation of AI in industry presupposes a comprehensive approach to the foundation of a regulatory framework in view of industry specifics.

The principle of development of human resources in the Intellectualization of industrial production is based on the need for comprehensive scientific and research support and training of qualified personnel in view of the industrial specifics of the industry. Specialists who obtain skills in this area are in demand for a successful implementation of AI technologies.

A model of competencies in the field of AI has been developed in Russia. It is implemented in universities and enterprises, and this allows training human resources, that will meet the requirements of digital transformation. All industries have their own specific characteristics, so scientific and educational programs must be tailored to their requirements, which increase the efficiency of the implementation of artificial intelligence.

The development of principles for Intellectualization in industrial production is indispensably important for ensuring technological sovereignty and sustainable economic development. They lay the basis for standardisation, security and effective implementation of AI, which directly influences the competitiveness of enterprises and the national economy as a whole.

[7] URL: https://www.economy.gov.ru/material/file/28a4b183b4aee34051e85ddb3da87625/20201222.pdf

Thus, AI technologies in industry are becoming a strategic tool that guarantees not only a growing, but also prospective economic security.

CONCLUSION

The fundamental core of Intellectualization resides within the transition from the mechanical use of information to intelligent, creative management of production processes, which allows generating a unique intellectual domain of the enterprise and adopting management solutions based on artificial intelligence and big data analysis. Such a transition contributes to the transformation towards more autonomous, efficient and competitive industry in the context of global digitalisation.

The eight principles of Intellectualization implied in industrial production are based on strategic documents, as well as on the analysis of the practice of implementing AI in various fields of industry. An integrated approach that takes into consideration the basic principles of the National Strategy for the Development of Artificial Intelligence for the period up to the year of 2030 contributes to the formation of a methodological basis for standardisation, security and effective implementation of AI in enterprises and makes up a criterion-oriented base for assessing and managing this process.

Thus, the Intellectualization of industrial production is not a mere technological trend, but also a strategic necessity that ensures sustainable development and competitiveness of enterprises in the epoch of the digital economy. The development and implementation of clearly formulated principles of Intellectualization builds a solid foundation for the effective and safe application of AI in industry, which ultimately contributes to the achievement of national objectives of technological development and sovereignty.

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Donald Trump's Climate Wars

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ABSTRACT

Relevance. The paper analyses the initiatives of the new US administration on the US withdrawal from the Paris Agreement and the revision of national climate policy. **Method.** The authors examine the main decisions of the Trump administration and unveils the impact of these decisions on the positions of the leading players in global climate policy. **Results.** Fundamentally, new issues have been identified, such as the dismantling of structures and initiatives that ensured the climate policy of the previous administration, the systemic impact on all components of the ESG agenda, and the termination of all US foreign policy initiatives and climate programs. **Scientific novelty.** A forecast is given of the possible directions of the greatest activity of the United States, tied to the climate agenda and recommendations have been developed on Russia's position in the field of climate diplomacy in the context of recent changes in US climate policy.

Keywords: greenhouse gas emissions; climate policy; Paris Agreement; existential threat; climate agenda; institutional and legal basis; ESG-agenda; United States Agency for International Development (USAID)

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The repeated US withdrawal from the Paris Agreement, as well as Donald Trump's second term in office, and his decision to pursue the policy aimed to develop the oil sector at the expense of green energy were easily predictable political events. Thus, the newly elected president lived up to expectations: his statement 'Drill, baby, drill!' has become a meme, and immediately afterwards, the share prices of leading oilfield services companies Schlumberger Ltd and Halliburton Company rocketed to new highs [1].

Although Trump's political maneuver largely resembles his withdrawal from the Paris Agreement during his first presidency, there is no complete analogy between these situations in 2017 and 2025: they are just worlds apart.

The first and foremost reason is the following: the White House has to operate in an extremely toxic environment generated by the Biden administration. During the latter's presidency, global climate change was declared an existential threat, and the climate agenda was positioned at the forefront of the US domestic and foreign policy and security as well, it has received ultra-high status and priority compared to other areas of US administration activity. This priority status was reinforced by appropriate organisational and managerial decisions: the entire state apparatus was thoroughly so to say "permeated" with climate-related vertical and horizontal power structures, as well as the climate-related functions of existing structures and new formations, including methods of coordinating the activity of departments.

American Climatic Jaggernaut

At the same time, two independent entities were set up to coordinate domestic and foreign climate policy. The first one was operating with the newly established "superstructure" of the Climate Policy Office. The head of the second entity is the Special Presidential Envoy for Climate John Kerry, a key player who has a whole staff of employees in the White House, however, actually, the support was provided by the National Security Council with its long-established channels and procedures for coordinating specialised agencies.

Not surprisingly, the former Secretary of State John Kerry took this position: he is well known for his status and political experience, as well as for his strong commitment. Back in 2019, he launched the World War Zero coalition, which attracted many politicians and media personalities, such as Bill Clinton, Jimmy Carter, Madeleine Albright, Arnold Schwarzenegger, Sting, Leonardo DiCaprio and other celebrities. The mission of this coalition was to combat the global climate change, and the method was the mass climate agenda indoctrination of activists all over the world.

The concept of a "global war on climate" has mirrored in the style and content of decisions taken by the Biden administration, as well as in the composition of the departments, which included all the security agencies: the US National Intelligence Agency, the Defense Department, the Committee of Joint Chiefs of Staff and the US Department of Homeland Security.

As to the US foreign policy related to the global climate change, the wording of Biden's executive order was unambiguous: "Climate change is the central component of the US foreign policy and national security".[1] Specifically, it was mandatory that federal departments and agencies engaged in international activities were required to submit their respective strategies and plans on this subject to the President.

As we can judge, the aforementioned strategy was put into practice for specific purposes unrelated to the preservation of the planet. In this particular instance, the United States mainly focused on the control over the global economy, taking no interest in the strategy of national governments, including the administration of development priorities, regulatory frameworks, norms and rules of corporate conduct and governance. This also includes the ESG-DEI[2] bundle of mechanisms.

How was this supposed to be possible? The programme-targeted management approach of the USA was implemented. Besides, as a foundation, they used the principles outlined in the US International Climate Finance Plan.[3] All departments involved in the US foreign policy and finance were supposed to participate. In particular, the State Department was required

[1] URL: https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tacklingthe-climate-crisis-at-home-and-abroad/); (https://obamawhitehouse.archives.gov/administration/seniorleadership/brian-deese

[2] Environmental, Social, Governance & Diversity, Equity, Inclusion.

[3] URL: https://bidenwhitehouse.archives.gov/wp-content/uploads/2021/04/U.S.-International-Climate-Finance-Plan-4.22.21-Updated-Spacing.pdf

to "leverage its significant diplomatic resources and foreign assistance to obtain a greater support from governments and civil society leaders, private sector representatives, and other stakeholders",[4] as well as to "focus on the effective implementation of the Paris Agreement". The primary objective of the strategy was to establish a universal, global vector for "decarbonisation and conservation of global warming within the limit of 1.5 °C".[5]

There is a strikingly remarkable discrepancy between the stated global warming limit (1.5 °C) and the goals of the Paris Agreement, which set the limit at 2 °C. This is evidently a manipulative tactic employed from the repertoire of climate alarmism: it is used to reinforce pressure on nations to relinquish organic fuels. This assertion is confirmed by the document, which enlists the international bureaucratic structures with which the State Department is obliged to collaborate, special focus is on the International Renewable Energy Agency (IRENA) and the International Energy Agency, well known as preeminent global advocates for renewable energy.

A particular emphasis was focused on the staffing project: the State Department was instructed to "expand diplomatic capacity and expertise in the field of climate change, including the creation of new climate-related positions in for this US embassies".[6] The plan also envisaged a comprehensive ideological indoctrination in the spirit of climate alarmism: all foreign policy officials indiscriminately were to undergo special training. The State Department received significant resources allocated to work with "employees engaged in targeted diplomatic interaction".[7] The intended meaning of this explicit terminology is quite apparent.

It is a well-known truth: "Warfare needs three fundamental elements: money, money and, once again, money". Consequently, the initiative of the Biden's administration received unprecedented financial support for the so-called "the zero world war". In accordance with documents, this involved "participation of over twenty US agencies, each with distinct instruments, mandates, and competencies. Enhancing their coordination will be imperative to ensure that the United States optimises its resource to make the objective realistic of achieving net-zero emissions by 2050 and maintaining warming limit below 1.5 °C".[8]

Global Climatic Dictatorship

The United States established its first most important instruments of global financial influence: international development banks (the World Bank, the International Finance Corporation, etc.). As it was declared, the main task for them was to restructure their policies to the climate priorities of the Biden administration. The US Treasury was envisaged to instruct the executive directors of multilateral development banks in which the United States is a shareholder to ensure financial support of the campaign against climate change in partnership with other shareholders. In this regard, the executive directors were supposed to encourage the adoption of more ambitious targets in this area, as well as to terminate formally financial support for the use of carbon-intensive energy sources based on fossil fuels at the international level.[9]

The global struggle against climate change necessitates the support for developing countries as they endeavour to fulfill and enhance their existing commitments in this field, provide the integration of reductions of greenhouse gas emission and foster climate change resilience into the long-term strategic frameworks. However, in view that the commitments undertaken by developing countries do not encompass emission reductions, this suggests a potential for a covert revision of the fundamental principles of the Paris Agreement (as was evidenced by the absence of temperature limits). Concurrently, preparatory measures for the alteration of commitments were authorised to the relevant parties within the respective countries, using climate finance as a decoy. Evidently, these actions were in line with the interests of the USA.

It is equally important the pivotal role of the US Agency for International Development (USAID) in

[4] URL: https://bidenwhitehouse.archives.gov/wp-content/uploads/2021/04/U.S.-International-Climate-Finance-Plan-4.22.21-Updated-Spacing.pdf

[5] Ibid.

[6] URL: https://bidenwhitehouse.archives.gov/wp-content/uploads/2021/04/U.S.-International-Climate-Finance-Plan-4.22.21-Updated-Spacing.pdf

[7] Ibid.

[8] Ibid.

[9] Ibid.

promoting American interests on the global arena. The Agency is responsible for more than half of all US foreign aid, the amount that is the most substantial in absolute monetary terms on a global scale. The functionality of this "soft power" instrument and the US influence of foreign policy has undergone a comprehensive "reprogramming" to align with the objectives of the climate agenda. The new strategy required that the Agency incorporate climate priorities into all its programmes, encourage other countries to adapt to climate change and to adopt transition to renewable energy sources. To achieve these objectives, the budget of the United States Agency for International Development (USAID) was strongly increased and additional personnel was hired. The anticipated outcome of such pressure is that sovereign countries make more ambitious emission reduction commitments.

Thus, by 2023, the budget of the Agency had reached 43 billion USD, so, it shoulders the financial activity of the Biden administration related to foreign climate policy. USAID spent enormous amounts of money to recruit allies, primarily from among small developing countries to secure the requisite votes in the context of global climate negotiations within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. It deployed arger-scale training and grant programmes to directly impact on the climate policies of countries worldwide, and generate a properly indoctrinated "human asset" among the leadership of the state apparatus and relevant climate non-governmental organisations.

USAID did not end up with these goals expanding the list of objectives and aiming to restructure global finance the way that would align it with the climate policy objectives of the Democratic Party. For this strategy, they launched a set of programmes and structures, namely:

- The USAID Climate Finance Investment Network for climate-related projects;
- The USAID Adaptation Financing Window;
- The USAID Climate Finance Development Accelerator;
- The Amazon Gender Equality Fund for Climate Change.

The ambitious set of goals for these structures included in particular a significant investment of 250 million USD in the USAID Climate Finance Accelerator, with the objective of attracting 2.5 billion USD in public and private climate investments by the year 2030. The overall goal of the Agency was to mobilise 150 billion USD to "combat climate change" by the year 2030.[10]

The US International Development Finance Corporation (DFC) was another financial pillar of Biden's foreign climate policy. The initiative was launched during Trump's inaugural term as the US president, when he expressed concern regarding the magnitude of Chinese investment on an international scale and criticised the obvious inability of US finance institutions to effectively compete with Chinese activities. The Corporation was designed originally as a risk management instrument for development initiatives of private sector-led companies. However, the Biden administration redeployed it towards alternative objectives. Thus, by 2023, the US international plan of financing the policy against climate change stipulated its necessity of increasing the share of climate-related investments to a minimum one third of the total.[11]

Trump Strikes Back

The Trump administration intends to abolish and completely undermine institutional and legal basis of the entire deeply layered structure of "climate bureaucracy" built by Biden's decrees. As many expected, Trump signed an Executive Order on the US withdrawal from the Paris Agreement in the first day of his presidency. In his inaugural address, he promised that he shut down Biden's "Green New Deal". Besides, he canceled the US International Finance Plan on Climate Change.

Under the influence of Elon Musk, Trump also took an unprecedented measure: the dissolution of USAID. Apparently, he understood that the process of transformation of the US "soft power" instrument into a tool of the climate lobby had gone too far.

In addition to that, the US Ambassador to the United Nations received the presidential order to promptly send an official document and notify the UN Secretary-General about the US withdrawal from the Paris

[10] URL: https://www.climatelinks.org/sites/default/files/asset/document/2024–10/Climate%20Finance%20Partnerships.pdf

[11] URL: https://bidenwhitehouse.archives.gov/wp-content/uploads/2021/04/U.S.-International-Climate-Finance-Plan-22.21-Updated-Spacing.pdf.

Agreement, as well as from any agreement, pact or similar commitments made in accordance with The UN Framework Convention on Climate Change (UNFCCC). The order also declared the withdrawal from the Agreement would come into force straight away upon notification.

Besides, the order terminated or cancelled any intended financial commitment made by the USA under the UNFCCC, although it was not announced any withdrawal from the UNFCCC.

Withdrawal from the Paris Agreement also means that the United States breaks its promise to reduce greenhouse gas emissions by 50–52 per cent by the end of the decade compared to the level of the year 2005. In addition, Trump promised to cancel a few federal measures aimed to fulfill the obligations specified in the Agreement. He commented the issue that thus, the United States "will save over a trillion dollars."

Thus, President Trump avoids his unlucky experience of 2017. In accordance with the regulations, a request for withdrawal from the Paris Agreement cannot be submitted earlier than three years after the date of its entry into force (November 4, 2016). One more year needs to be accounted to this period for granting approval to the request. As a result, the USA formally withdrew from the Agreement on November 4, 2020, the day after the presidential election won by Joseph Biden.

This ambiguous situation enabled many US states and municipal authorities to disregard directives of the federal government and wage their own climate policies, including their own regulations of greenhouse gas emissions. Specifically, in 2017, thirty states and many US cities preserved their loyalty to the objectives of the Paris Agreement.

This time, Trump is determined to prevent such a self-opposition, besides the current situation is significantly much more favourable for the new administration. The three-year period has passed long enough since the Agreement came into force. The only remaining formal requirement in Article 28 stipulates that any withdrawal shall take effect one year after the date the depositary received the notification. However, Trump has actually ignored this regulation when he declared that the United States would withdraw from the Agreement right away upon sending the aforementioned notification.

ESG In Question

However, the issue has become more comprehensive, in view of the role of the climate agenda for the state and in business, including the ESG format, for which it has become a backbone in current years alongside the DEI ideology. The ESG principles, which combine climate dogmatism with the dictatorship of minorities, have become the ideal tool for the "deep state" to control the entire corporate world. This situation does not obviously fit well with President Trump's declared "common sense revolution", which implies a return to the traditional role of the state.

The nexus of ESG-DEI has completely saturated global business, instilling it with its rules and regulations, so that confronting such deeply layered entities seems to be a very difficult challenge. However, without resolution of this issue, the US withdrawal from the Paris Agreement will be taken on an international scale as a pointless gesture, and Trump's policies will be assessed as a number of declarations, which lack effectiveness.

Another problem is that in current years the universally acknowledged 'trendsetter' in the ESG agenda in the corporate world has been the mega-holding company BlackRock. The latter has supplied a biased personnel to Biden's cabinet and the US government in accordance with the traditional American practice of "revolving doors" (rotation of executives between public sector and private sector roles). BlackRock representatives have taken key roles in the Biden administration, and they operated there not just as lobbyists, but as influential figures in shaping rules and parameters of the game in so-called "climate cabinet".

The ESG agenda adopted by the holding company has allowed establishing a notable presence in global politics: it has become the primary consultant of the European Commission on the integration of ESG issues within the framework of financial regulations. In fact, this arrangement provided BlackRock a dominant controlling position within the European financial system, as the holding corporation was entrusted with the responsibility to administer its restructuring in accordance with ESG priorities.

The company exercised its many-tentacle tactics on government policy and directly made an influence on corporate strategy through its role in and over the

head of the American government. In conjunction with other mega-holdings, including Vanguard and State Street, it initiated the involvement of US industrial companies in climate initiatives such as Climate Action 100+ and the Net Zero Asset Managers Initiative, whose objectives were far from compatible with the interests of the real sector.

This contradicted Trump's established priorities, so he made an online speech of European ESG regulation at the Davos Forum on January 23, 2025. Not by chance, Trump's criticism of the European bureaucratic regulations was orchestrated by a pertinent remark of another US participant of the online panel discussion in Davos — Stephen A. Schwarzman, Chairman, CEO and Co-Founder of Blackstone: "A lot of the European business people have expressed enormous frustration with the regulatory regime in the EU".[12]

President Trump criticised European realities and then presented his ultimatums. In March 2025, the US embassy in Paris dispatched correspondence to a group of French companies, requiring their immediate cessation of their DEI policies. In March 2025, the US embassy dispatched correspondence to a group of French companies, demanding the immediate cessation of their DEI policies. The issue was starkly challenged: the entities were required to terminate immediately their DEI programmes, otherwise they would be removed from the federal government's list of suppliers, facing the prospect of non-payment even for existing contracts. The companies were requested to complete a designated form and confirm their adherence to the provisions of US law. If they agree, the US administration would enable the transfer of funds.

The Figaro newspaper observed that the Trump administration had been waging a ruthless warfare on DEI programmes, and that the consequences are already reaching far across the Atlantic Ocean [2]. Events unfolded rapidly in the USA: the next day after Trump's inauguration, an executive order was issued against "illegal" DEI policies. The US corporations faced a complicated situation, as they had previously regarded ESG as mandatory and even quite unassailable.

The executive order with a meaningful title "Ending Illegal Discrimination and Restoring Merit-Based Opportunity" placed federal contractors under the obligation to certify that they "do not engage in unlawful discrimination, including unlawful DEI".[13] Government agencies received instructions to compile a list of national corporations, large non-profit, other private sector entities, foundations, and professional associations and universities for investigation of violations of this particular law. Regarding DEI programmes in the public sector, the federal government and the armed forces, Trump has adopted the directive for immediate termination of the programmes, as well as closure and elimination of all associated offices and positions.

The activity of mega-holdings to engage industrial corporations in climate initiatives that prove to be commercially disadvantageous were not forgotten too: the Republicans deployed immediately its initial retaliatory action following the election, even prior to Trump's inauguration. A block of American states, headed by Texas, initiated legal action against BlackRock Inc., Vanguard Group Inc., and State Street Corp. These corporations were indicted for violating antitrust laws through the manipulation of electricity prices by means of investment strategies.

Ken Paxton, Attorney General of Texas, along with his counterparts from ten other US states, made a challenging declaration: financial managers of mega-holdings jointly with members of climate change groups engaged a campaign to exert pressure on coal producers, compelling them to curtail their production. Consequently, due to the lawsuit filed in a Federal Court in Texas, residents of Texas and other states were compelled to pay higher electricity bills due to local power shortages [3].

The US major corporations seemed to have responded to the Republican Party's call to action, withdrawing from international climate initiatives such as Climate Action 100+, the Net Zero Asset Managers Initiative etc. These initiatives, including the Glasgow Financial Alliance for Net Zero (GFANZ), gradually move under the auspices of the Bloomberg group. Notably, Mark Carney headed GFANZ and previously was the Chairman of the

[12] URL: https://rollcall.com/factbase/trump/transcript/donald-trump-speech-virtual-world-economic-forum-january-23–2025/

[13] URL: https://www.whitehouse.gov/presidential-actions/2025/01/ending-illegal-discrimination-and-restoring-merit-based-opportunity/

Board of Directors of Bloomberg Inc. and the Governor of the Bank of England, until his appointment as Prime Minister of Canada on March 14, 2025. This means the possibility of a transfer of patronage over the agenda to British governing structures.

A notable manifestation of rejection of the ESG agenda in the USA was the stance adopted by Institutional Investor, a US entity that grants awards of acknowledgement for outstanding achievements among financial analysts in the Wall Street sector. In 2024, the ESG category declared no winner and from 2025 onwards, the annual analyst rankings abolished this category. Coming back to Paris Agreement, what was the reaction of the global community about Trump's decision, and the implications for the future of this global climate agreement?

Reaction of Major Global Players

A spectrum of opinions ranged from negative to positive. In particular, Argentine President Javier Milei has stated that his country would possibly consider following the suite of the United States to withdraw from the Paris Agreement. He recommended the statement that global warming "has nothing to do with human presence", and pointed out that climate change is "linked to the planet's natural temperature cycles".[14] Milei's statement was announced immediately after Argentina declared its withdrawal from the World Health Organization, following the suite of the United States as well. However, there might be a temporary challenge for Argentina to compromise relations with its closest neighbor, Brazil, which will host the next UN Climate Conference in November 2025. Anyway, this circumstance does not prevent Milei from returning to this issue after the completion of the UN Climate Conference.

The statements of many other players have altered in tone, ranging from expressions of politically correct regrets (China, EU) or even complaints (African group of countries) with criticism of a lack of common sense (Brazil) and covert threats to interact with American actors over the head of the federal government (UK, Canada). It is worth paying attention to the response of some distinguished individuals, such as Kim Darroch, former British ambassador to the US, and John Ashton, Special Representative for Climate Change at the UK Foreign and Commonwealth Office (2006–2012): "We must collaborate with individuals in the USA and other countries who comprehend the necessity of concluding the fossil fuel era with utmost urgency" [4].

It is not hard to predict how Donald Trump would react to such a stance of Britain to influence US domestic policy, since he has repeatedly claimed that he expected that Europe would jump to make large-scale purchases of American oil and LNG [5]. Hypothetically, this standpoint articulated by senior British politicians who retired and still live in their memories links to realities that prevailed during the period of 2017–2020. That was the time period of "protracted" withdrawal of the United States from the Agreement, which offered substantial autonomy to individual states and market participants who openly expressed dismal views over the American administration. The current circumstances would unlikely allow them to do so, due to the defeat of "the climate establishment" inflicted by Trump.

It would be probably beneficial for Trump's supporters to express gratitude to their British opponents for their honesty in declaring the true objective of the so-called struggle for the climate ("bring an end to the fossil fuel era as soon as possible"). This clearly brings them on opposite sides of the barricade with Trump and his concept of energy dominance.

Nevertheless, it would be unwise to underestimate high-ranking British retirees, who follow traditional way to express any idea only with greenlight approval from the authority above. Moreover, Ed Miliband, the Secretary of State for Energy Security echoed their statements in a more diplomatic way. Being a supporter of the "net zero" concept, he declared in the House of Lords that he would "try to find common ground" with Trump, and that the "national interest" of the United States still lies in tackling the climate crisis [4].

We do not focus on how Trump may react to the statement of the British minister, who claimed that he knew better, than the Americans temselves, what were the national interests of the USA. What is more important, that the reaction of Great Britain to Trump's decision turned out to be the most harsh and aggressive: the UK openly threatens the USA with war on their own turf by the actors committed to the climate agenda.

[14] URL: https://www.batimes.com.ar/news/argentina/milei-says-hes-considering-taking-argentina-out-of-paris-agreement.phtml

What does this mean for the global climate negotiations? As far as we can judge, the policy of the US president have compelled the UK to adopt a leadership role (even conceptually) in the climate agenda, which it usually avoided. However, if we take into account the transition of global climate initiatives under British control, then it is evident that this issue encompasses a broader scope.

Such decisions could be a forced step in a complicated situation: the US decision to withdraw from the Paris Agreement signals a significant shift in the balance of power in global climate negotiations. The USA was the major participant in the group of the most aggressive advocates of tough national commitments to reduce emissions and abandon organic fuels. It also has the greatest resources, qualified personnel, "soft power" structures and, consequently, the most powerful opportunities to influence the negotiation process. This indicated during the Biden's presidency, when capabilities of the American "climate establishment" were unspooled to the full swing, in conjunction with the resources of the European Union and the United Kingdom, and this enabled to obtain unprecedented results. In particular, the UN and its structures were determined as the primary global lobbyists for the climate agenda, with the UN Secretary-General António Guterres designated as the global front man for this agenda. These efforts resulted to the destructive terminology regarding organic fuels at the UN Climate Conferences in Glasgow (2021) and Dubai (2023).

The reaction of the UK and global climate lobby was not limited to verbal statements: they deployed such tried and tested methods as announcing novel, alarmist predictions that threatened humanity with unprecedented disasters due to climate change. In particular, experts from British-controlled Australia predicted that a 4 °C warming would result in an average 40 per cent decrease in wellbeing for a median person. In March 2025, economists from the Climate Risk and Response Institute at the University of New South Wales (UNSW) claimed that all previous economic models had underestimated the impact of global warming. They further stated that if global temperatures rose by 4 °C, average GDP per capita would decrease not by 11 per cent (as previously stated), but by as much as 40 per cent [6].

However, some experts in Australia consider such forecast optimistic: for example, Mark Lawrence, professor of the University of Adelaide, believes "the economic consequences [of climate change] could be even worse". Australian scientists also devote particular attention to oppose the common point of view that not everyone will lose out from global warming, namely, that Russia, Canada and the countries of Northern Europe may benefit from it. Thus, Timothy Neal from the University of New South Wales claims that all countries suffer damage, so that, cold regions will not benefit, since "global economy is deeply interconnected by trade" [6]. The reader is welcomed to assess the level of such argumentation.

The international bureaucracy, embodied by the United Nations Development Programme (UNDP) and the Organisation for Economic Co-operation and Development (OECD), did not hesitate to intervene. In March 2025, they released a report with predictably alarming figures of the global losses resulting from the "climate crisis" and the expected positive outlook for the global economy if trillions of Dollars allocated to fight against it. According to this report, in the current century, a failure to curb the "climate crisis" would result the loss of a third of global GDP. However, a reduction in greenhouse gas emissions could lead to an increase of global GDP by the end of the next decade. At the same time, if by 2050 large-scale investments to be deployed, the indicator of GDP in the most developed economies will become 60 per cent higher than in 2025, and it will be even 124 per cent higher in the lower-income countries [7].

Obviously, Trump's team had been seriously preparing for this conceptual assault long time ahead, and they responded immediately. Even during his first presidential term, Trump pointed out his intention to sort out with funding of a closely-knit group of climate alarmists in science, who had been pressuring their opponents for many years in the spirit of cancel culture. Retribution inevitably returned to the alarmists like a boomerang at the beginning of 2025, when the US administration ordered to cease providing support for scientific research in the USA and abroad that contained the terms "climate", "DEI" and "climate crisis" [8].

As to the UN structures, the complaints lodged against them are more serious, as they require fundamental reorganisation. Trump declared, that the

United Nations should realign its core focus with its "fundamental purpose": namely, the maintenance of international peace and security. The US administration used to express its stance on the irrelevance of a particular issue for the UN, when it withdrew from corresponding multilateral agreements or when it terminated their financing [9]. It is easy to figure out the fate of these structures predestined by the United States, if we recall Trump's decisions on the UNFCCC, including American participation and funding.

It is complicated to predict whether such tactics will be extended to other players, which are dependent on the USA, due to the extremely high level of uncertainty in world politics in general, and, above all, in military and political stability.

CONCLUSION

1. The US withdrawal from the Paris Agreement is the "tip of the iceberg": it presupposes a whole set of lesser-known measures by the Trump administration to purge the state apparatus, the political class and the business elite of supporters of climate alarmism. Nowadays, they dismantle the structures, management procedures and regulations formerly integrated within the entire state apparatus, the upper echelons of major corporations and financial institutions under the Biden's administration.

2. In the foreign policy, this trend leads to dissolution of entities and cancellation of initiatives launched during the Biden's administration, including the Climate Finance Plan, USAID etc., aimed mainly at enhancing the climate ambitions of the countries participating in the Paris Agreement.

3. It could be asserted, that the most authoritative participant drops out from the global climate negotiation process, which has created a whole arsenal of pressure tools for this purpose and has forced sovereign countries to agree to ambitious plans to reduce greenhouse gas emissions. This factor reduces risks for Russia in adoption of additional commitments under the Paris Agreement, which may be against the interests of national development. Concurrently, the lack of American support significantly reduces the EU's potential for "enhancing climate ambitions."

4. The changing situation in the near future will inevitably make an impact on the wording of the UNFCCC, its general statements will most likely prevail over specific figures. It is hardly possible that the European Union and the United Kingdom will be capable of achieving a comparable outcome, similar to that of the 28th UN Climate Change Conference held in Dubai in 2023, which many regarded as the danger sign for fossil fuels within the near future. This provides with an opportunity for BRICS to make their voice heard in the upcoming climate negotiations, including the rejection of the most unacceptable formulations for the Alliance and the Global South.

5. The US withdrawal from the Paris Agreement does not indicate a rejection of the UNFCCC. It is quite probable that the Trump's team will resort to this mechanism for influencing the negotiation process as soon as a loyal group of negotiators is formed who support the values of the US administration. The priorities and tactics of this group will become evident at the upcoming UN Climate Conference in Brazil scheduled for November 2025.

6. For now, one can only guess in the general terms what ideological underpinnings the Trump's team is preparing to replace the climate agenda. However, since the USA used to impose its internal priorities on the global arena, it is possible to foresee a reversion to the classical concept of sustainable development in the form, that existed in the late 1980s, before the introduction of the climate component, which eventually took a leading place in it and has actually replaced it in recent years.

7. The replacement of the terminology "ESG" with "sustainability" in the vocabularies of American politicians and businessmen in recent days suggests that the substitution of the concept of "ecology" with "climate" is coming to a close. Hopefully in the not near future, a "common sense revolution" will occur in this area, with the tasks of protecting and preserving the environment being presented in the classical sense. However, this will not exclude the need for energy conservation and energy efficiency previously linked to the climate agenda.

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Reforming the Dated Brent Oil Benchmark

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ABSTRACT

Subject. The 2023 reform of the Dated Brent benchmark, one of the world's most important crude oil pricing indicators, marked a significant development in the global commodities market. As part of this reform, the West Texas Intermediate (WTI) Midland grade was added to the Brent basket. **Objective.** This article examines the goals and intentions of the reform's initiators and developers who revised the Dated Brent assessment methodology in 2023. It also explores the key factors that made the reform possible. These include the depletion of North Sea oil fields — which for decades served as the physical basis for Dated Brent — the surge in U.S. production of light, low-sulfur crude oil, and European Union sanctions against the Russian oil industry. These sanctions have triggered a sharp increase in U.S. hydrocarbon exports to Europe. **Findings.** The study demonstrates that the reform was also driven by unsuccessful attempts to create an influential oil benchmark based on U.S. crude exported from Gulf of Mexico ports.

Keywords: global economy; oil benchmark; oil price indicators; Dated Brent; WTI Midland; infrastructure factors in the development of the global oil market

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INTRODUCTION

The notion that the modern global crude oil market is inherently unpredictable and volatile is virtually axiomatic. Price shocks represent the most extensive and disruptive manifestations of these characteristics: each has significantly transformed the oil industry, sometimes in a fundamental way — either creating new operating conditions and setting trends, or accelerating processes that had begun in previous years. One area where the impact of such price shocks is most consistently observed is the very system of price formation in the global crude oil market.

The first oil shock of 1973 ended the dominance of major vertically integrated oil companies from the United States and the United Kingdom in this sphere and marked a transition of international oil trade toward reference prices set by the Organization of the Petroleum Exporting Countries (OPEC). The most important among them became the price of Arab Light crude produced by Saudi Arabia [1].

The second oil shock of 1979–1980 created the conditions for increased production outside OPEC, which ultimately led to a weakening of the organization's influence. The sharp and deep decline in oil prices in 1986 undermined the dominance of OPEC reference prices and paved the way for the formation of the modern oil pricing system, centered around global market benchmarks such as Platts Dated Brent (Dated Brent), Platts Dubai, and NYMEX WTI [2]. The first two represent daily price assessments for tanker cargoes on the relevant spot markets, both published by Platts, while the third is an index based on the price of the WTI futures contract traded on the New York Mercantile Exchange (NYMEX). The oil shock of 2008, in turn, contributed to the success of the U.S. shale oil revolution, which in subsequent years strengthened the position of NYMEX WTI, whose credibility had previously been questioned [3,4].

At the same time, the 2020 oil shock "created a new reality for the global oil industry — and indeed for the global energy sector as a whole" [5]. In particular, it spurred U.S. oil corporations to intensify efforts in developing new solutions in the field, culminating in the June 2023 reform of Dated Brent and all related Brent basket indicators. The demand for reforming the global crude oil benchmark had been articulated long before, but the extraordinary events of 2020 accelerated this process and largely shaped its direction.

THE 2020 OIL SHOCK AND THE EROSION OFTRUST IN NYMEX WTI

The oil shock that struck global energy markets in the spring of 2020, unlike most previous ones, was not triggered by a supply shortage but by an unprecedentedly rapid and deep collapse in demand. This shock sharply intensified competition in the largest segment of the global energy market. As a result, massive stocks of unsold crude oil accumulated, while demand for storage capacity surged dramatically [6]. On April 20, 2020, after five weeks of extremely painful decline, the price of the May NYMEX WTI futures contract experienced an unprecedented collapse into deeply negative territory (–$ 40.32 per barrel) [7]. To this day,[1] this event remains largely unexplained and once again raised doubts about the adequacy of the North American benchmark [8]. By contrast, the world's leading reference marker — Dated Brent — demonstrated far greater consistency with the actual conditions of the global physical crude oil market [9]. The same applies to the ICE Brent Futures contract.

Just two months later, at the end of June 2020, Platts and Argus simultaneously began publishing assessments for light sweet West Texas crude destined for exports through U.S. Gulf Coast ports. Notably, both price reporting agencies refrained from referencing its traditional name,[2] West Texas Intermediate (WTI[3]). Instead, they labeled this "branch" of the WTI stream identically as American Gulf Coast Select (AGS). Platts explicitly stated

[1] URL: https://www.cftc.gov/PressRoom/SpeechesTestimony/berkovitzstatement112320a

[2] URL: https://www.prnewswire.com/news-releases/sp-global-platts-launches-new-benchmark-for-us-crude-platts-american-gulfcoast-select-301083750.html

[3] URL: https://www.prnewswire.com/news-releases/argus-launches-new-benchmark-for-growing-us-crude-oil-hub-301084369.html

that this decision was driven by market demand arising from the events on the New York Mercantile Exchange (NYMEX) two months earlier.

Both Platts and Argus cited the profound structural changes in the U.S. oil industry brought about by the shale revolution as the main reason for introducing AGS. Whereas in 2008 the United States produced 1.83 billion barrels (approximately 250 MMT) of crude oil, by 2019 this figure had increased almost 2.5 times to 4.49 billion barrels (about 615 MMT), and in 2023 it reached 4.72 billion barrels (around 647 MMT.[4]).

A much faster increase was observed in crude oil exports from the United States: 168 million barrels (about 23 MMT) in 2015 (the year the previous export restrictions were lifted); 1.09 billion barrels (approximately 149 MMT) in 2019; and 1.49 billion barrels (around 204 MMT) in 2023.[5] A significant share of these exports was WTI crude from the Midland area in West Texas. Accordingly, in a number of its reports, Platts referred to this stream as WTI Midland and, in August 2020, published its quality specs. It was this crude that became the basis for Platts AGS assessments in June 2020, while Argus AGS relied on a similar grade with comparable characteristics. However, these new assessments failed to gain the confidence of most exporters and importers. The pricing formula for cargoes of West Texas crude continued to rely on the North Sea benchmark Dated Brent or on indicators derived from ICE Brent futures. As for domestic U.S. deliveries, the above-mentioned price indicators were not designed for pipeline-based North American transactions, where NYMEX WTI remained dominant.

The failure of the new light sweet oil assessments revealed the inability of the selling companies — including major oil traders — to create an influential benchmark, even one closely linked to the global one. The price of cargoes of oil produces in West Texas and New Mexico (as well as all grades produced in the Atlantic Basin) remained pegged to Dated Brent — the world's most influential crude oil benchmark. It should be noted that, due to the high degree of liberalization in international oil trade as well as of trading operations in crude oil major consumers (such as North America and the EU), the sector has suffered from a lack of reliable information since the late 1980s. As a result, assessing the true influence of any particular benchmark is extremely difficult. Nevertheless, the core role of the Brent basket price indicators is beyond dispute, even if experts may disagree over the precise figures.

According to Mike Wittner, Head of Oil Market Research at the Intercontinental Exchange (ICE), "The price of about 78% of all crude oil traded globally — that is, exported physical oil — is directly or indirectly linked to the Brent benchmark." [10] Notably, the ICE Brent futures contract is traded on the ICE itself, and its price, in various combinations, is used to form a number of indicators within the Brent basket. Moreover, the Dated Brent benchmark is used not only to determine the price of crude oil but also that of petroleum products, liquefied natural gas (LNG), liquefied petroleum gas (LPG), and gas condensate. The failure of Platts AGS and Argus AGS can be attributed to a combination of factors, most notably:

- the absence of universally accepted General Terms and Conditions (GTCs) for light sweet U.S. crude exported abroad;
- high geographical diversification of supply routes;
- and uncertainty among non-U.S. participants in the global oil market regarding the full applicability of international commodity trading practices to transactions conducted within waters that fall under the exclusive economic zone of the United States.

High production volumes did not help either, which once again demonstrated that, by itself, this undoubtedly important factor is insufficient to guarantee success in creating a crude oil pricing benchmark. In our view, it was only after it became clear that the growing flow of U.S. seaborne crude oil would be "linked" either to Dated Brent or to indicators based on ICE Brent futures that American oil companies set a course to integrate the increas-

[4] URL: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPUS 1&f=A

[5] URL: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCREXUS 1&f=A

ingly prominent crude stream from West Texas into the Brent basket (essentially aiming to secure a dominant position for WTI Midland within these indicators), with the intention of "becoming the global leader in the pricing system with a single WTI price benchmark" [11].

THE EVER-CHANGING DATED BRENT

It should be noted that by this time the North Sea benchmark was also experiencing challenging conditions. The price reporting agency Platts, its publisher, once again faced the classic issue affecting oil benchmarks: a decline in the production of the grades that underpin Dated Brent [12]. Although high or very high production volumes of a particular crude do not automatically qualify it as a benchmark crude, a sharp decline in production for an already established benchmark poses a serious challenge and can undermine market confidence in it [13]. Such confidence depends on influential market participants for the relevant crude grade, an assessment methodology recognized by them, and a sufficient number of price signals.

For this reason, the entire history of Dated Brent, created by Platts in 1987, can be seen as a series of reforms aimed at aligning the benchmark with these conditions as recognized by key Brent market participants [14]. Initially based on crude from the Brent field — the largest field connected to the Brent pipeline system and forming part of the Brent grade — the benchmark had, by 2017, expanded to include five light sweet grades (the Brent Blend, the Forties Blend, Oseberg, Ekofisk, and Troll) sourced from dozens of North Sea fields. In 1990, the substantial Ninian crude stream was added to the original Brent grade, giving rise to Brent Blend, commonly referred to simply as Brent. In the same year, Shell U.K. Limited developed the General Terms and Conditions (GTCs) for tanker transactions in the Brent market, which became the standard for all its participants The Cash BFOE forward market, critical for other benchmark indicators, fully adopted Shell's GTCs. However, by 2002, Brent Blend production had declined to the point that it became necessary to create the Brent basket, comprising quality-equivalent crudes: the British Brent Blend and Forties, and the Norwegian Oseberg. In 2007, the basket was expanded to include the Norwegian Ekofisk, and the Forties stream was supplemented by crude from the Buzzard field. The BFO basket evolved into BFOE, and in 2018 the Norwegian Troll grade was added.

Despite the similarity in physicochemical properties, these crude streams were not identical in quality, which necessitated the introduction of adjustment factors in the Dated Brent assessment methodology: discounts for the Forties Blend, referred to as a "sulphur de-escalator" due to its higher sulfur content, and quality premiums (QPs) for the Norwegian grades (Ekofisk, Oseberg, and Troll) [15].

By early 2019, it became clear that the process of adjustment would not end with the inclusion of Troll in the Brent basket. In February, Platts announced that starting in October, both Cash BFOE and Dated Brent assessments would take into account information on offers for sale under CIF Rotterdam terms. Until that point, for over 30 years, only FOB deals had been considered. On one hand, this decision increased the number of price signals from the then Brent basket, but on the other, it opened the way for inclusion into the basket crude streams from outside the North Sea.

Following the inclusion of Troll, the Norwegian state oil and gas company Statoil (now Equinor) assumed a dominant position in the Brent market. The data and transaction information from Statoil were used to calculate Cash BFOE (Brent forward market indicator), Dated Brent (Brent spot market indicator), the ICE Brent Index (Brent futures market indicator), as well as related swap contracts. By early 2020, it was evident that production of the five aforementioned marker crudes in the Brent basket would continue to decline, as most of the fields had been in operation since the 1970s-1980s, and depletion was a natural consequence. In 2020, their combined production amounted to only 0.87 million barrels per day (approximately 43.5 MMT per year, i.e., less than 1% of global output[6]) and

[6] URL: https://www.argusmedia.com/en/news/2204216-maintenance-project-delays-sap-north-sea-liquidity

Table 1

Qualitative Characteristics of Selected North Sea Crude Grades and WTI Midland

Oil type	Density, (API)	Sulfur, % mass	Production Volume (million barrels/day, Jan- Jul 2024)
Brent blend	37.5	0.4	0.025
Forties blend	41	0.55	0.18
Oseberg	39.6	0.2	0.1
Ekofisk	38.5	0.19	0.13
Troll	37.5	0.15	0.09
Johan Sverdrup	28.7	0.81	0.22
WTI Midland (Platts)	40.0–44.0	⩽ 0.2	1.078 (2020)

Sourse: compiled by the authors: URL: https://www.spglobal.com/commodityinsights/plattscontent/_assets/_files/downloads/crude_grades_periodic_table/crude_grades_periodic_table.html

Table 2

Qualitative characteristics of West Texas Intermediate (WTI) Crude Oil and Its Variations

Oil type	Density, (API)	Sulfur, % mass	Production Volume (million barrels/day, Jan- Feb 2025)
WTI	37–44	⩽ 0.42	4.4
WTI Cushing (NYMEX)	37–42	⩽ 0.42	–
WTI Midland(Platts)	40–44	⩽ 0.2	–

Sourse: compiled by the authors: URL: https://www.rystadenergy.com/trading-signals-macro-trends https://www.cmegroup.com/markets/energy/crude-oil/light-sweet-crude.contractSpecs.html;

continued to fall. Several industry experts and companies, including the competing price reporting agency Argus, proposed further expanding the basket to include Johan Sverdrup, another Norwegian grade. However, the proposal was rejected, formally on the grounds that the candidate crude had higher density and sulfur content. It cannot be ruled out, however, that the true reason was the reluctance of Anglo-American companies to allow dominance by grades supplied by the Norwegian state oil and gas company Statoil.[7]

THE MOST COMPLEX REFORM IN DATED BRENT HISTORY

As early as late February 2020, Platts, the administrator of the Dated Brent benchmark, stated that it did not see the urgent need to add new grades to the Brent basket,[8] in the near term. However, by early December of the same year, the price reporting agency officially invited market participants to provide their opinions on the inclusion of West Texas Intermediate (WTI) Midland under FOB Scapa Flow delivery terms. Platts noted that this North American grade was finding an increasing number of buyers in the UK and EU and, in terms of quality, was close to the five North Sea grades (*Table 1*).

According to Platts, total WTI Midland production in 2020 amounted to 1.078 million barrels per day, of which approximately 0.443 million barrels per day were estimated to be supplied to Europe. It was observed that the proposed inclusion would

[7] URL: https://www.argusmedia.com/en/news-and-insights/market-opinion-and-analysis-blog/the-crude-report-wti-swallows-brent

[8] URL: https://www.reuters.com/article/oil-brent-wti-idAFL5N 2AO2TZ

provide additional volumes of crude with similar quality, necessary to support the Dated Brent FOB benchmark. At the same time, WTI Midland (as interpreted by Platts) differs in characteristics from the WTI Cushing crude stream, which is the underlying asset for the NYMEX WTI futures contract (*Table 2*). The changes were scheduled to take effect in March 2022.[9]

The decision announced by Platts on 22 February 2021 (formally on the basis of the results of the consultations) caused an explosive reaction in the global crude oil market, as it differed drastically from the initial proposals in one highly significant aspect: the agency declared the abandonment of the traditional reliance on tanker shipment data under FOB terms in favor of CIF-based data. The market's response, including that of the ICE commodity exchange, was so decisive that by 10 March 2021,[10] Platts was forced to withdraw its February decision, retain FOB as the primary delivery term, and launch a new round of consultations [16]. Fifteen months later, a new decision emerged, whose implementation required another year of extensive revisions and coordination with key market participants handling light sweet crude from the North Sea and West Texas. From the outset, there was no full certainty that the main actors in the global crude oil market would broadly accept the inclusion of WTI Midland into the industry's most critical benchmark.

Platts' first success on this path came on 21 July 2021, with the publication of a joint circular[11] issued with the Intercontinental Exchange (ICE). The circular provided a concise overview of the indicators used in the North Sea oil market, which are based on the data from its forward, spot, and futures segments, as well as from related swap markets. It explicitly reaffirmed the determination of the Dated Brent and ICE Brent Futures administrators to preserve the traditional nature of all these indicators, using cargo shipment data under FOB terms (and CIF, as per Platts' 2019 practice). After acknowledging the clear need to incorporate additional volumes into the basket of marker crudes, the circular identified two preferred candidates: the Norwegian Johan Sverdrup and the North American WTI Midland. A key part of the circular consisted of a list of questions for market participants regarding problematic aspects of the proposed reform, the most challenging of which concerned the inclusion of the new grade(s) in the Brent forward contract. This clearly indicated that the questions were primarily addressed to Shell, the holder of the GTCs generally accepted in the North Sea forward market. Even a large vertically integrated company could not disregard the fact that two highly influential global oil market infrastructure organizations had consolidated their positions. As subsequent events demonstrated, it was precisely the adoption of new GTCs by Shell for WTI Midland that made possible the reform of the aforementioned indicators, including Cash BFOE, Dated Brent, and the ICE Brent Index. With the support of the Intercontinental Exchange, Platts on the same day (21 July 2021) officially announced for the second time the launch of consultations on the reform of Dated Brent and other Brent basket indicators.

Platts' official proposal to market participants following the consultations was published seven months later, on 14 February 2022. Its adoption, with certain modifications, became virtually inevitable by May–June 2022, when the EU first approved the REPowerEU plan (aimed at reducing dependence on energy imports from Russia) and subsequently adopted its sixth sanctions package against Russia, which, among other measures, banned the import of Russian seaborne oil starting in December. It became clear that the options for most European countries in this sphere were sharply limited, making the supply of large volumes of light sweet crude from North America

[9] URL: https://www.spglobal.com/commodityinsights/en/our-methodology/subscriber-notes/120320-sampp-global-platts-opens-consultation-on-inclusion-of-wti-midland-crude-in-dated-brent

[10] URL: https://www.spglobal.com/platts/en/our-methodology/subscriber-notes/031021-platts-opens-further-consultation-on-brent-benchmarks-transition

[11] URL: https://www.spglobal.com/commodityinsights/PlattsContent/_assets/_files/en/our-methodology/platts-ice-brent-july-2021.pdf

(where it faced limited domestic demand and significant surplus) to the EU and the UK unavoidable. Consequently, the positions of companies supplying such crude on the international market were significantly strengthened. In this context, Shell faced two options: either participate in the reform and revise its general terms and conditions (GTCs) for transactions in the North Sea oil market, or cede this crucial element of the entire Brent basket indicator system to competitors. Shell chose the first option, amending the relevant contract on 23 May 2022. This was not a finalized document, but rather a declaration of intent to include WTI Midland in the contract.

Just four days after the adoption of the sixth sanctions package, on 8 June 2022, Platts officially announced its decision regarding the Dated Brent benchmark reform[12]:

- to include North American WTI Midland crude in the Brent basket, with an API gravity of 40–44° (804–823 kg/m^3) and sulfur content not exceeding 0.2% by mass;
- to apply no quality premiums for WTI Midland;
- when converting the price of WTI Midland cargoes on a CIF Rotterdam basis to the FOB standard used for cargo valuation, to apply a Freight Adjustment Factor (FAF) of 80%;
- to increase the size of the standard Aframax tanker cargo acceptable for Dated Brent assessment from 600,000 to 700,000 barrels;
- for Dated Brent assessment, to consider only those WTI Midland cargoes shipped from the US Gulf Coast terminals that had been pre-approved by Platts;
- the changes apply to cargoes of the six grades in the expanded Brent basket starting June 2023 and thereafter.

The most complex issue — determining which general terms and conditions (GTCs) would apply — was deferred. However, the timeline was clear: the new rules would take effect in February 2023, with June 2023 serving as the M3 month for the Cash BFOE forward contract. Accordingly, Shell's new GTCs (STASCO Cash BFOETM 2022 v1.1) came into force in February 2023, paving the way for the implementation of the reform of the Dated Brent benchmark and other Brent basket pricing indicators. Proposals to replace Shell's contract with alternatives offered by other companies, notably BP, were rejected, although such options were actively discussed in industry publications as late as autumn 2022.

The June 2023 data showed that the number of price signals used by price reporting agencies to assess Brent basket indicators increased approximately 2.5 times compared to the pre-reform average. Moreover, out of 22 trading days, Dated Brent was determined 18 times by the price of cargoes arriving from overseas.[13] Thus, an immediate consequence of the reform was the dominance of North American crude in the global crude oil benchmark.

Analysis of the 2023 changes indicates that inclusion of WTI Midland in the basket of marker grades helped stabilize Dated Brent by introducing new volumes and new market participants, primarily from North America. Their influence on the global crude oil benchmark increased accordingly, which was precisely their objective. Given wide spread sanctions and the threat of additional measures (e.g., tariffs on oil shipments to the U.S. from Mexico and Canada), it is difficult to assess the impact of the reform on market confidence. However, Platts regards the emergence of new participants as evidence of increased trust. Clearly, the influence of companies producing the five original North Sea grades, including the Norwegian Equinor (formerly Statoil), has diminished, while "the effective integration of the two key global benchmarks … significantly enhances the influence of U.S. oil production on the global crude oil pricing process" [17].

While the addition of WTI Midland resolved the pressing issue of declining liquidity in the Brent basket market, it also raised certain questions.

[12] URL: https://www.spglobal.com/commodityinsights/en/our-methodology/subscriber-notes/060822-platts-to-reflect-wti-midland-in-dated-brent-cash-bfoe-from-june-2023

[13] URL: https://www.argusmedia.com/en/news-and-insights/market-opinion-and-analysis-blog/the-crude-report-wti-swallows-brent

First, which market does Dated Brent actually reflect? Previously, the price of North Sea crude delivered on FOB terms served as an indicator for the light sweet crude markets across the entire Atlantic basin. Now, with tankers arriving in Rotterdam from the far side of the Atlantic, it is evident that the U.S. oil market in the EU countries that lost Russian supply is much more specialized (albeit larger in scale). The assumption that a CIF price, converted to FOB by subtracting freight, can be treated as an FOB-equivalent was acceptable when it did not determine Dated Brent in 18 out of 22 trading days per calendar month. Today, however, this assumption is increasingly questionable.

Secondly, since their inception in the late 1980s, benchmarks were formed based on data from a specific crude stream with well-known characteristics. This cannot be said of Platts WTI Midland, which was included in the Brent basket in 2023 — it represents only a portion of the broader West Texas pipeline blend (WTI). According to Rystad Energy, by early 2025, total production of this blend was approximately 4.4 million barrels per day, of which around 3 million barrels per day do not find buyers in North America and are exported, with 52% directed to European markets.[14] Therefore, in the case of Platts WTI Midland, it represents roughly one-third of total WTI volumes. Regardless of what share of WTI Midland transactions is captured in the data used by Platts to assess Dated Brent, the key fact remains: two-thirds of WTI consistently targets entirely different export destinations.

Consequently, Dated Brent has, on the one hand, ceased to be an indicator of the exports price of light sweet crude and has become a reflection of Western European refineries' import demand for North American crude. On the other hand, the determining factor is now the price of such crude at the U.S. Gulf Coast, which bears no direct relation to North Sea grades. It is unclear how relevant this assessment is for the broader market, given that in most cases it is based on data covering only one-third of total WTI volumes shipped across the Atlantic to specific destinations. Recognizing the fragility of this situation, market participants are asking: when should the next reform be expected, and which grade will become the seventh in the Brent basket? Confidence is further undermined by the highly complex and increasingly judgment-dependent methodology employed by Platts to assess Dated Brent, particularly concerning its application to the core element — forward contracts in WTI Midland.

Questions also arose following the October 2024 Reuters report indicating that not all WTI Midland tankers recorded by Platts as destined for European markets were actually delivered there [18]. According to Reuters, some of this crude was redirected to Asia-Pacific countries after the cancellation of the original contracts. In this context, it is crucial to note that reported trades carry significantly higher priority and weight than most other data, thus exerting a decisive influence on the final benchmark assessment.

However, in our view, the central question is whether the inclusion of WTI Midland in the Brent basket represents the first step toward making light sweet crude shipped from U.S. Gulf Coast ports the de facto single stream underpinning the world's most important oil benchmark. If, following the failed launch of the AGS indicators in summer 2020, the chosen path was indeed a gradual adaptation of the Dated Brent assessment mechanism to the North American export-oriented crude flow from Texas (and possibly Louisiana) ports, then the global oil market may find itself in a situation where two of its three key indicators are based on U.S.-produced crude.

In this regard, it is worth noting the regularly published announcements by North Sea operators (notably TotalEnergies, EnQuest, and Taqa) to fully cease production at several well-known fields (Ninian, Marnus, and Cormorant, respectively). It should be emphasized that, once production declines to a certain threshold, maintaining the costly offshore drilling rigs, pipelines, and port infrastructure will become economically unviable for all fields relying on that infrastructure.

[14] URL: https://www.argusmedia.com/en/news-and-insights/market-opinion-and-analysis-blog/the-crude-report-wti-swallows-brent

This will result in a sudden instantaneous drop in production of one of the North Sea marker grades included in the Brent basket, forcing U.K. and EU refineries to once again expand crude imports from the U.S. The growing dominance of North American crude in the Brent basket will inevitably trigger a new global benchmark reform, potentially excluding the fully depleted Brent field. Implementation of such a scenario would resolve most of the issues that arose from the Platts decisions of 2021–2023, effectively reflecting their transitional nature from Brent to an updated American GulfCoast Select — essentially the present-day WTI, a shale crude oil stream by its characteristics.

CONCLUSION

The multi-year preparation and implementation in 2023 of the reform described above demonstrated the complexity and variability involved in making changes, even to a well-established mechanism governing the indicators of one of the key segments of the global crude oil market, as well as the associated challenges. The reform also highlighted the significant role played by both the infrastructural organizations of the global oil market and the largest vertically integrated energy companies. In our view, studying the reform carried out two years ago, along with the evolution of Dated Brent, provides extensive material for understanding the mechanisms underlying the formation and functioning of this pricing benchmark. This knowledge can be effectively applied to the development of domestic price indicators for Russian crude grades exported by sea. Analyzing such experience in the context of current conditions in the target markets for Russian crude oil will allow for optimization of the process, saving both time and resources.

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The Impact of China's Import Substitution Policy on Bilateral Trade with the United States

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ABSTRACT

Relevance of the research topic is determined by the growing role of import substitution policy in the development of national economy of the People's Republic of China and its impact on the structure of bilateral economic relations with the United States. Import substitution allows China to reduce dependence on external supplies while stimulating the development of its own high-tech industries, significantly affecting the trade balance between the two largest global economies. The purpose of this article is to analyze the impact of China's import substitution policy on bilateral trade with the United States, including assessing its consequences for exports and imports, as well as changes in the trade strategies of both countries. Methodology: the study used statistical data, official reports, and scientific publications, as well as comparative and systemic analysis to identify trends and factors which made an impact on trade and economic relations between the People's Republic of China and the United States. Scientific novelty: the article singles out specific aspects of China's import substitution policy of the most significant effect in the context of its impact on trade with the United States, such as high-tech industries and agriculture. The article has advanced for the first time a comprehensive approach to evaluate such impact, taking into account international economic conditions and political tensions. Research results prove that import substitution policy of the People's Republic of China leads to structural changes in bilateral trade. Namely, it was revealed, that the Chinese strategy of import substitution stimulates the development of domestic production, reducing imports from the United States in several sectors of industries, while China's exports turned out to be more diversified. The analysis also shows that the United States, in turn, increases trade protectionist policies in response to changes in Chinese policy. The practical significance of the research work refers to the recommendations for government agencies, the business community, and research institutions interested in cooperation strategies and adaptation to new circumstances in global trade, as well as for analysts involved in forecasting potential scenarios in the trade conflict between China and the United States.

Keywords: import substitution; international trade; China; United States; bilateral economic relations; trade balance; protectionism; export; import

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INTRODUCTION

Modern global economy is experiencing the period of dynamic structural transformations, which is mainly due to a changing geopolitical landscape and enhanced global competition. One of the key trends is the striving of states to strengthen their own economic security, including through a policy of import substitution. Trade disputes, digital transformation, and growing protectionism necessitated such an important instrument for maintaining internal industry and reducing dependency on external suppliers [1].

Given global leadership in the sphere of technology and industry, particularly interesting is the confrontation between the two major world economies: the People's Republic of China and the USA. The bilateral trade tension is closely related to China's attempts to increase its technological independence and competitiveness in high-tech sectors, as well as the US reaction to take measures of protecting its own market.

The policy of import substitution serves as one of the key mechanisms to stimulate industrialisation and strengthen national production, which enables the following:

- decrease dependency on external supplies of goods and technologies;
- support domestic producers, creating jobs and developing infrastructure;
- build a stable industrial base and enhance competitiveness on foreign markets.

However, an extreme accent on import substitution can lead to price increases, quality reduction, and a decline in innovation, if domestic competition becomes insufficient. That is why state strategy often assumes a balance between supporting measures for national producers and preserving transparency for foreign trade.

China and the USA constitute a gross part of global GDP and world trade turnover. Since 2018, their trade conflicts have become one of the major factors of world trade volatility. Growing tariffs, trade restrictions, and mutual sanctions have urged China to develop its own production capacities in such strategically important sectors as high technology, electronics, automotive manufacturing, pharmaceuticals, etc.

In this case, the policy of import substitution not only facilitates the growth of domestic production, but also directly influences the structure of import and export, thus creating a new configuration of bilateral trade turnover. To assess its influence on the structure and dynamics of bilateral Sino-US trade, and to identify the main trends in addition to risks for the world economy, it is necessary to solve the following tasks:

- analyse the key aspects of the import substitution policy and its role in the global economic development of nations;
- review statistical data of trade turnover and identify changes in the structure of Chinese and US exports and imports;
- evaluate the US responsive measures (protectionism) and their impact on the trade balance;
- determine the prospects of further development of bilateral ties in the context of global competitiveness and economic security.

ANALYTIC INSTRUMENTS OF THE ECONOMIC POLICY OF CHINA AND THE USA

To analyse the impact of China's import substitution policy on bilateral trade with the USA, the authors used scientific research of official statistical documents: reports of the National Bureau of Statistics of China, the US Bureau of Economic Analysis, publications of international institutions, such as the World Bank, IMF, and WTO [2].

The following research methods were applied:

- statistical analysis, enabling to reveal key trends in the change of the structure of export and import;
- comparative analysis, needed for juxtaposing trade indicators of both countries, and their dynamics related to other economies;
- economic-mathematical modelling (CGE-models), enabling to estimate the potential impact of import substitution on bilateral trade flows;

• content-analysis of trade and economic strategies, including state programmes of China (for example, "Made in China 2025") and the US trade policy [3].

The aforementioned methods enable to make an all-round analysis of changes in the structure of bilateral trade, to assess the impact of import substitution on strategic sectors, and to identify the US responsive measures in the context of increasing protectionism.

STRUCTURAL CHANGES OF THE SINO-US BILATERAL TRADE

In current years, the structure of export and import of both states has undergone substantial changes, which is largely influenced by trade disputes, increasing protectionism, and fast-rising development of high-tech branches. The analysis of statistical indicators allows for identifying the main trends, exerting a long-term impact on the Sino-US bilateral trade-economic relations *(Table 1)*.

According to the aforementioned data, the volume of trade turnover noticeably decreased in 2019 against the backdrop of escalation of trade conflicts, manifested in the growth of tariff and non-tariff barriers. However, the subsequent period indicated a recovery and growth of bilateral trade, especially evident clearly in 2021–2022. The figures of 2022 reached peak values, which testifies the sustained high demand for goods from both countries, despite the existing restrictions. In 2024, a trend is traced towards a certain reduction in the export volumes of China to the US, although, a comprehensive analysis of this shift requires the accounting of data for the whole year (*Fig. 1*).

The China's export of cutting-edge production to the American market is of high priority. Over half of it includes electronics and electric goods, which testifies to the consolidation of China as a key link of global supply chains for these sectors. A significant share also falls to machinery and equipment. As to the traditional Chinese sphere of production of textiles and clothing, it indicates stable volumes, although gradually losing its dominant position amid the development of more science-intensive industries [4] *(Table 2, Fig. 2)*.

China's import constitute the largest share (30.5 per cent) of agricultural production, which reflects its requirement and dependency on food security and supplies of strategic agricultural crops, e.g. soybeans. High indicators in aviation and automotive products point to a significant demand for production of these branches. Semiconductors and chips are also important, especially considering the expanding digitalisation and development of various industrial sectors [5] *(Table 3, Fig. 3)*.

Thus, we may highlight the following major indicators [6].

Table 1

Trade Turnover Between China and USA in 2018–2024, billion US dollars

Year	China's Export to the USA	China's Import from the USA	Trade Turnover
2018	478.4	155.1	633.5
2019	418.5	122.7	541.2
2020	451.8	124.6	576.4
2021	506.4	151.1	657.5
2022	536.8	153.8	690.6
2023	536.75	153.84	690.59
2024*	427.8	–	564.17

Source: compiled by the authors.
Note: * data for the first 10 months of 2024.

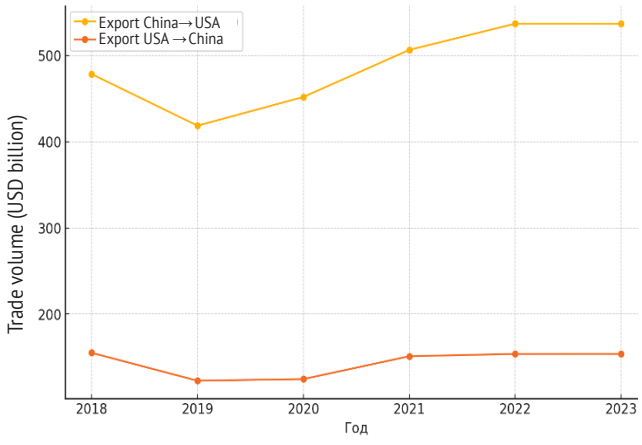

Fig. 1. **Export-Import Dynamics Between China and the USA in 2018–2023, billion US dollars**

Source: ccompiled by the authors.

Table 2

Structure of China's Exports to the United States by Major Commodity Categories in 2022, %

Product category	Share in export
Electronics and electric goods	50.2
Machinery and equipment	20.3
Textiles and clothing	10.5
Toys and sports equipment	7.8
Other commodities	11.2

Source: compiled by the authors.

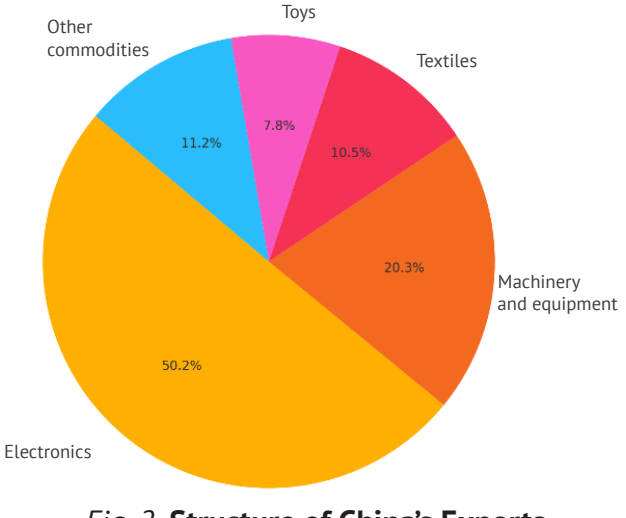

Fig. 2. **Structure of China's Exports from the USA by Main Commodity Categories in 2022**

Source: compiled by the authors.

Total trade turnover. Following a decline in 2019, related to the expansion of trade conflicts and the introduction of additional tariffs, the volumes of bilateral trade gradually recovered. In 2022, trade turnover reached 690.6 billion USD, a record indicator for the analysed period.

Chinese export to the USA. Despite trade restrictions in 2022, the volume of Chinese export to the USA comprised 536.8 billion USD. This confirms a stable demand from the American market for Chinese electronics, machinery, and other industrial goods.

Chinese Import from the USA. Imported products from the USA totaling approximately 153.8 billion USD in 2022 include a wide range of high-tech goods and agricultural products. These stable indicators reveal the interest of China in US technologies and raw materials, despite difficult political ties.

Structure of trade. China focuses on supplying electronics, machines, and textiles to the US market. However, the key import items of for China remain agricultural goods, aviation technology, and automobiles. This reflects a high degree of complementarity for both economies. At the same time, China seeks to develop its own high-tech productions (especially in the sphere of semiconductors), which in perspective can influence the volumes of import of corresponding goods.

The presented statistical data and their graphic demonstration testify that, despite the existing trade barriers and political factors, bilateral trade retains its significance for both countries. The changes in the structure of export and import occur under the impact of import substitution processes, growing competition in the technological sector, and US protectionist policy measures. Subsequently, the dynamics of trade turnover will depend on how the two states balance economic interests with political priorities, as well as on the global macroeconomic trends and the state of the international financial system [7].

The structural shifts in Sino-US export and import, presented in the above tables, make a complex influence on the global distribution of competitive advantages and, consequently, create

Table 3

Structure of China's Imports from the USA by Main Commodity Categories in 2022, %

Product category	Share in import
Agricultural production	30.5
Aviation products	25.7
Automotive products	15.3
Semiconductors and chips	12.8
Other commodities	15.7

Source: compiled by the authors.

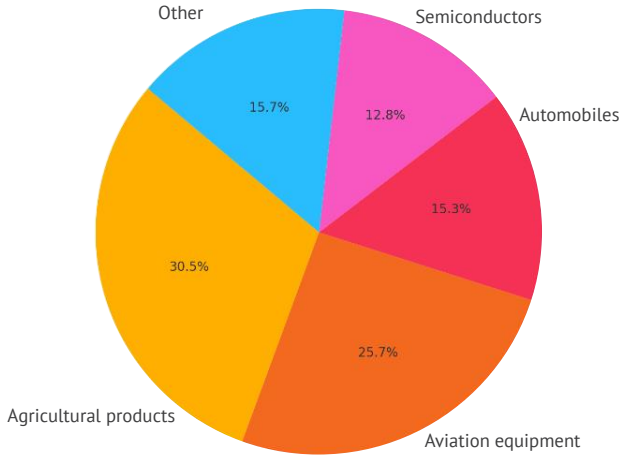

Fig. 3. **Structure of China's Imports from the USA by Commodity Categories in 2022**

Source: compiled by the authors

a new balance of interests in the world economy. The predominant high-tech emphasis of Chinese export (electronics, machines, and equipment), which was recorded in 2022, means that the country is building up technological independence and striving to consolidate a leading position in global value chains. Concurrently, the stable high-share dependency on US-imported goods (aviation technology, semiconductors) in strategic demand indicates the presence of a definite degree of complementarity of both economies. Thus, China has a dual objective, to have access to the newest technologies, and on the other hand, to reinforce internal scientific-technological potential and develop its own production [8].

The situation in the USA is also of dual context. A strong demand for the production of the US high-tech sector (especially, in the field of aviation and automotive manufacturing) sustains its competitive positions in certain segments. It ensures significant export incomes collectively, however, the preserved dominant role of China in the production of electronics and electric technology generates fears, related to the long-term decline of US industrial and innovative leadership (especially if trade restrictions fail to build alternative supply chains) [9]. As a result, both countries have to navigate between the need for cooperation in sensitive technological areas and the desire to protect their own markets, which increases the risks of the global economic fragmentation. China keeps building up the export of finished high-tech items, strengthens the localisation of production, and concentrates on import substitution. Meanwhile, the USA keeps defending the strategy of technological supremacy. Thus, the future reallocation of competitive advantages could prove to be highly substantial for these two major economies and for the entire world trade system [10].

OPPORTUNITIES AND CHALLENGES OF SINO-US TRADE POLICY

Examining the dynamics of trade turnover in the tables above, it becomes obvious that Chinese import substitution policy makes an impact directly on the structure and extent of bilateral trade. The core idea of import substitution boils down to reducing dependency on foreign supplies, particularly in strategically important brunches of industries, and developing domestic production. In practice, this means active state financing of innovative programmes, incentives for local producers, and the introduction of various benefits or subsidies, that allow Chinese companies to reinforce their positions in the internal and global markets.

Examining the key sectors, where China seeks domination (according to data from *Table 2*), approximately 50.2 per cent of supplies comprise electronics and electrotechnology, and another

20.3 per cent is attributed to machines and equipment. These figures are highly indicative, demonstrating that China has already succeeded in building powerful production chains competitive even in the US market, where domestic high-tech corporations are traditionally strong. Chinese companies demonstrate a growing ambition to avoid critical dependency on imported components, which is particularly strong, concerning microchips or other special equipment supplied in large amounts from America.

Concurrently, American authorities manifest a similar corresponding reaction. The tariffs and restrictions imposed on Chinese goods in the late 2010s and 2020s largely demonstrate a reply to growing concerns that Chinese import substitution policy threatens the traditional technological leadership of the USA. After all, if China domestically learns to produce all key elements of high-tech products (from processors to aerospace components), this would undermine the influence of external channels and competitive advantages of American business.

However, judging by the dynamics of export-import operations, the imposed US trade restrictions has failed to torpedo the growth of Chinese exports, which, for instance, in 2022 reached 536.8 billion USD despite all existing barriers. This is not only due to a powerful production base of China, but also thanks to a strong demand among US consumers for relatively inexpensive and high quality Chinese goods. Such stability bolsters confidence of Beijing that the strategy of import substitution, encouraged by state support, really helps national companies become more competitive and less vulnerable to fluctuations in the world market.

As a result, import substitution becomes an instrument of long-term competitive struggle: China is not merely shielding from external influence and instability. It is effectively building a system, where domestic producers gain access to the financial and institutional resources essential for active development. This, in turn, deepens the misbalance in bilateral trade: the US increasingly fears losing market share and the leakage of key technologies, meanwhile China, implementing its programmes, increases its exports of finished high-tech products to America. Consequently, this may escalate trade conflicts, since either side interprets the other's measures as negatively influencing its economic security.

Despite all controversies, both economic giants remain the largest trading partners for each other, as was evidenced in 2022 by the data of annual trade turnover of more than 690 billion USD. However, their sustained interaction does not guarantee harmony in their relations. The complex political environment and competition for global leadership leave their mark on every transaction, e.g., the supply of agricultural products: 30.5 per cent of China's import from the US or the purchase of electronics 50.2 per cent of China's export to the USA.

On the one hand, both countries have an objective need for cooperation. China needs American technology, but even more so, stable global markets for its goods. The United States, in its turn, finds it crucial to save access to the rapidly growing Chinese market, especially in such segments as aerospace technology (25.7 per cent of import), automobiles (15.3 per cent), as well as the abovementioned agricultural products, the export of which brings substantial income for the US agro-industrial sector. On the other hand, a clear discrepancy arises: America strives to protect its technological supremacy and high-paid domestic jobs and meanwhile China continues to strengthen its own production capacity, more actively introducing import substitution and developing technology parks, laboratories, and innovation clusters.

Political tension is affected furthermore by external factors, such as increased attention to issues of national security, cybersecurity, and the control of exports for key technology. Each new US package of restrictive measures or any high-level statement on the impermissibility of technology transfer leads to a reaction from Beijing, which has already proven that it obtains enough resources and expertise to replace step-by-step a portion of imported goods with domestic production. Over time, such a political line may lead to

a more expressed split in the world market, so that both states will intensively diversify their cooperation geography, striving to reduce such a critical bilateral dependency.

Due to this context, there are potentially negative and relatively positive scenarios. The first one implies a further escalation of conflicts, when tariffs and sanctions grow, international mechanisms such as the WTO turn out to be unable to resolve disputes, and enterprises massively abandon joint projects. If so, both countries would face losses: the efficiency of global production chains would decrease, business costs would rise, and this would hit the end consumer.

The positive scenario presumes that, a certain degree of pragmatism and understanding of the scale of mutual benefits will lead to maintaining a restrained partnership of both sides in a number of key sectors, e.g., by implementing joint projects in energy, ecology, healthcare, and scientific-research development. Even if technological competition intensifies, preserving robust economic ties in other areas could defuse tension and potentially resolve a full-scale conflict. This requires permanent communication at both diplomatic and expert levels, as well as clear rules of the game, so that restrictions should not be introduced abruptly without preliminary consultations.

In general, the prospects for bilateral relations amid frictions look equivocal. Although trade and investment interdependence is still very high (which is beneficial for both states), the general course towards import substitution and protectionism could wreck an already unstable foundation for bilateral relations. That is why much will depend if both sides manage to find common points of contact with focus for mutual cooperation rather than for potential geopolitical benefits of one-sided measures.

Over the past several years, both states have been involved in a rather complex relationship in trade, technology, and politics. Despite existing restrictions and tariffs, they still develop trade ties actively. However, they risk a significant increase in mutual competition related to import substitution, particularly in high-tech sectors.

This is due to the fact, that such policy implies a deliberate refusal from foreign goods to be substituted gradually with domestic analogue products. As to China, it engages large-scale state programmes of support of domestic manufacturing entities: from electronics and telecommunications to automotive manufacturing and pharmaceuticals. This active reorientation results in the loss of a significant share of the market for the US entities, which does not suit the US government and prompts it to escalate more barriers or fortify export control. China, in turn, regards this as a policy to curb its economic and technological growth and responds with reciprocal measures, for instance, by increasing tariffs on key American goods or enforcing its own restrictions.

All these measures feed the fire for further escalation of trade conflicts. Gradually, each side has to seek forcedly alternatives in other markets to lessen dependence on such an inconvenient partner. Ultimately, the global economic system risks ending up between by two heavyweight players competing with each other for technological superiority, by means of creating around themselves various blocks of suppliers and consumers.

To avoid this scenario, it is important to understand, that any sanctions and tough tariffs have side effects, which affect the entire global economy. A particularly important role can be played by regular negotiations, both bilateral and mediated by international institutions (e.g., the WTO). Even if political contacts are complicated, flexible formats for expert meetings and business consultancy can partially mitigate conflicts. An important mechanism for reducing tensions serve joint projects in the field where the parties do not even have common interests directly or where the benefits of cooperation are clearly greater than the losses from confrontation: such as environmental issues, disease control, or development of specific scientific research initiatives. Finally, it is fundamentally significant to attract business communities and sectoral associations in the dialogue: eventually, they are the most vulnerable players in trade wars, and therefore, mostly motivated to seek compromise.

However, regardless all contradictions, there are a few areas where the parties can interact with mutual benefit, such as "the green economy" and eco-technologies. The global course to reduce harmful emissions and make transition to renewable energy sources requires immense joint investments and efforts. China is a world leader in the production of solar panels and batteries for electric vehicles, while the United States has a notable potential of scientific technology and advanced innovative start-ups. By integrating their capabilities, both states can make significant breakthrough in developing ecologically clean transportation and improving energy conservation methods.

Medicine and biotechnologies are among other promising collaboration platforms. The COVID-19 pandemic has demonstrated the importance of global scientific collaboration, specifically in the development of vaccines, drugs, and treatment methods. China and the USA obtain many research centres, universities, and pharmaceutical entities that could share data and technologies in the framework of joint projects. This would not only contribute to the benefit of public health in both nations, but also strengthen their positions as leaders of the world market.

Besides, the information technology and communications sector deserves special attention, since China is a trailblaser in developing equipment for 5G/6G networks, while the USA is a leader in software and artificial intelligence. Global agreements on cybersecurity, data protection, and creation of common standards of technology are in higher demand despite vigorous competition. This enables building clear rules of interaction that would reduce the risk of a technological split, which would make countries end up sharing or developing the same platforms.

Finally, one should not ignore innovations in outer space research and exploration of distant planets. The USA and China have already deployed large-scale space programs and, potentially, can conduct mutual scientific research, share space weather data, and coordinate spacecraft missions. Such collaboration not only ensures scientific breakthroughs but also generates the prerequisites for broader mutual understanding.

Even amidst trade conflicts and strategic rivalry, China and the United States remain major partners. Maintaining or even strengthening collaboration in such spheres as ecology, biotechnologies, information systems, and space research, they are able not only lower the risks of further confrontation, but also allow themselves and the world community to enjoy benefits from cutting-edge developments and share science-intensive technologies.

CONCLUSIONS

Chinese policy of import substitution has exceeded common protection of the domestic market and become a comprehensive strategy focused to strengthen national production and accelerate the development of high-tech sectors.

The reorientation towards internal resources, combined with extensive state support, has encouraged the development of key sectors (electronics, mechanical engineering, telecommunications), which ensured the growth of Chinese exports to the USA and consolidating its position in global production-supply chains.

Introduction and imposing more sever tariffs, sanctions, and export restrictions by the USA triggered China's growing impact on the world market. Such tactics create objective prerequisites for the further enhancement of conflicts, although this has not led to a substantial reduction in bilateral trade turnover.

Despite political disagreement and protectionist measures, both countries are still common largest trading partners. Thus, dependency on imported technologies and raw materials drive them to seek a balance between competition and collaboration.

The data of the tables above confirm that China reinforces its positions, as a supplier of high-tech production, while the USA remain a major source of strategic goods and technologies (agriculture, aviation, semiconductors). This implies the complementarity of both economies and potential possibility of collaboration in certain areas.

Collaborative work in such sectors as energy and pharmaceuticals could mitigate confrontation and foster the development of new forms of cooperation.

Intensified measures of import substitution and spiraling trade conflicts between the two largest global economies lead to destabilisation of global supply chains, growing prices for end consumers, and slowing down the progress of innovation in multiple sectors.

In order to reduce tensions, effective negotiation formats are necessary, as well as multilateral institutions, and involvement of business, scientific communities, and industrial associations interested in long-term stability and development of global trade.

Despite all differences in political and economic interests, China and the United States retain the potential for mutually beneficial collaboration, specifically in environmental, medical, digital, and space projects, where the synergy of technologies and resources will boost the global competitiveness of both nations.

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Opportunities and Prospects for the Transformation of the Russian Economy Based on the Sustainable Development Goals

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ABSTRACT

The **aim of this article** is to identify key directions for the transformation of the Russian economy and to develop policy recommendations for implementing the sustainable development agenda. The author employs **methods** of comparison, deduction, induction, analysis, synthesis, and analogy. The study identifies essential factors for the successful transformation of the economy and proposes financial instruments and mechanisms to advance the sustainable development agenda. Recommendations are formulated to ensure the long-term sustainability of the Russian economy through the development of creative industries, the expansion of sustainable finance markets, the use of public financial policy instruments, and the strengthening of cooperation between the state and business sectors. Promising areas of cooperation with BRICS countries in the field of sustainable development are also outlined. The **theoretical and practical significance** of the research lies in its identification of key success factors for economic development under new conditions and the proposed recommendations for transforming the Russian economy in line with the principles of sustainable development. **Future research** will focus on assessing the role of social and environmental capital in shaping a sustainable development economy.

Keywords: structural transformation of the Russian economy; BRICS sustainable development agenda; carbon market; human capital; sustainability bonds; financial market; corporate social responsibility; innovative development; creative economy; Sustainable Development Goals (SDGs).

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INTRODUCTION

The current state of the global economy and financial markets is characterized by a high degree of uncertainty, primarily driven by rising geopolitical tensions. A serious challenge complicating international cooperation in achieving the United Nations Sustainable Development Goals (SDGs) is the imposition of sanctions by developed countries. However, despite the contradictory nature of relations between states, the importance of sustainable development issues continues to grow for all major economies. Successful economic development under present conditions depends on the greening of production and the reduction of harmful emissions, the advancement of culture and education, and the introduction of innovative technologies in key industries.

The transformation of the largest developed and emerging economies in line with the principles of sustainable development is manifested in the following trends:

- pursuit of carbon neutrality;
- adaptation of corporate business models to ESG factors;
- increasing capitalization of markets for green and social financial instruments;
- integration of sustainability considerations into investors' financial strategies;
- development of systems for disclosing non-financial information on sustainable development goals;
- introduction of regulatory requirements in this sphere.

Both Russian and international scholars have examined conceptual as well as specific issues of sustainable development that require resolution. Researchers generally agree that the transition of the economy to a new trajectory enhances corporate competitiveness, fosters a more comfortable living environment, and promotes the creative potential of citizens. In the long term, adherence to ESG principles reduces social and environmental risks associated with business operations, improves the quality of corporate governance, and creates new opportunities for economic actors — including access to financing, higher energy efficiency, and the adoption of creative ideas and innovations.

One of the studies emphasizes the importance of achieving climate objectives within the global sustainable development agenda [1]. The authors conclude that a significant increase in spending on these goals is necessary: according to their estimates, an additional 3.8% of global GDP may be required by 2030.

Another study demonstrates the complex interrelationship between various sustainable development goals and highlights the need to account for country-specific conditions, as well as to strengthen international cooperation in policy implementation within this domain [2].

In a study devoted to assessing the impact of sustainable development factors on the value of Russian companies, it is emphasized that progress in this area enhances firms' investment attractiveness and increases their market capitalization by reducing business risks and lowering the cost of borrowed capital [3]. A study by Chinese scholars confirms the importance of integrating sustainable development principles into the operations of companies in the People's Republic of China. It highlights the positive relationship between a company's innovative activity and its commitment to these principles [4].

Examining organizations operating in the field of art, Russian researchers conclude that the creative industries[1] play an important role in the economies of the country's regions and that it is essential to make full use of their creative potential [5].

The study focusing on human capital assesses different stages in the development of the Russian economy from this perspective and notes the complexity of the ongoing transformation processes [6].

ENSURING LONG-TERM ECONOMIC SUSTAINABILITY IN THE NEW ENVIRONMENT

When formulating economic policy, it is essential to take into account both the Sustainable Development Goals defined by the United Nations General

[1] The creative economy includes sectors whose development is based on the use of employees' creative abilities and innovative technologies..

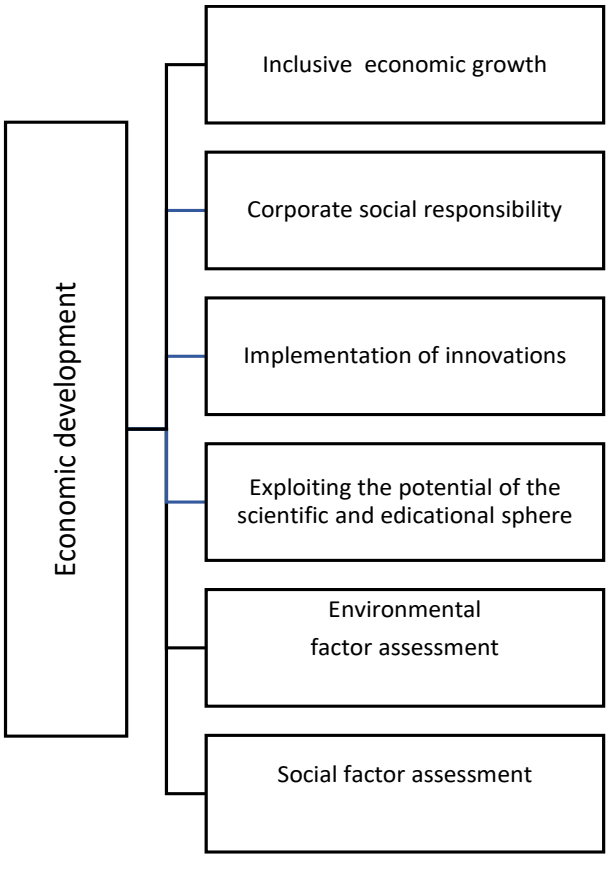

Fig. 1. **Key Factors for Successful Economic Development**

Source: compiled by the author.

Assembly[2] and the national priorities determined by the country's specific challenges. Ensuring the long-term sustainability of the economy requires the development of a new model aimed at improving quality of life and human capital (see *Fig. 1*).

The significant growth of instruments related to the sustainable development agenda, along with increased attention from issuers, investors, and regulatory authorities, indicates the formation of a new segment — the sustainable finance market, which is closely integrated with the global financial system [7].

In 2024, the issuance of bonds within this segment exceeded USD 1.1 trillion, while the total volume of all outstanding issues reached USD 6.2 trillion (see *Fig. 2*). As of the end of 2024, the average annual amount of sustainable lending and the total volume of loans issued over the period 2022–2024 amounted to $ 790 billion and $ 3 trillion,[3] respectively.

The growth in capitalization and development of this segment create new opportunities for attracting private investors to projects and expanding the number of market participants, enabling them to improve management systems in terms of environmental and reputational risk. Sustainable finance markets are particularly important for developing countries [8], as they provide:

- conditions for integrating sustainable development principles into corporate business models;
- engagement of credit institutions in implementing the sustainable development agenda;
- informational transparency and the establishment of disclosure standards in this field;
- regulatory incentives to increase the number of projects that take sustainable development goals into account.

The domestic financial market is characterized by a wide variety of sustainable finance instruments, including bonds, loans, and credit products that meet established criteria, as well as carbon units [9]. For the Russian economy, loans and

According to the rating agency Expert RA, as of July 1, 2024, the volume of sustainable development lending amounted to 5.5 trillion rubles and continues to grow. The majority of this volume was accounted for by loans linked to sustainable development performance indicators (49.6%) and "green" loans (41.5%).

The bond market used to finance sustainable development also maintains a positive growth trend (see *Fig. 4*). However, its overall volume remains relatively small due to internal factors — such as the high key interest rate set by the Bank of Russia and the shortage of long-term funding among credit institutions — as well as external constraints limiting access to international capital markets. The key participants in this segment are state-owned banks and development institutions, which act as both arrangers and investors.

In the context of adverse external and internal factors, the need to support the sustainable

[2] URL: https://undocs.org/en/A/RES/70/1

[3] URL: https://efdata.org

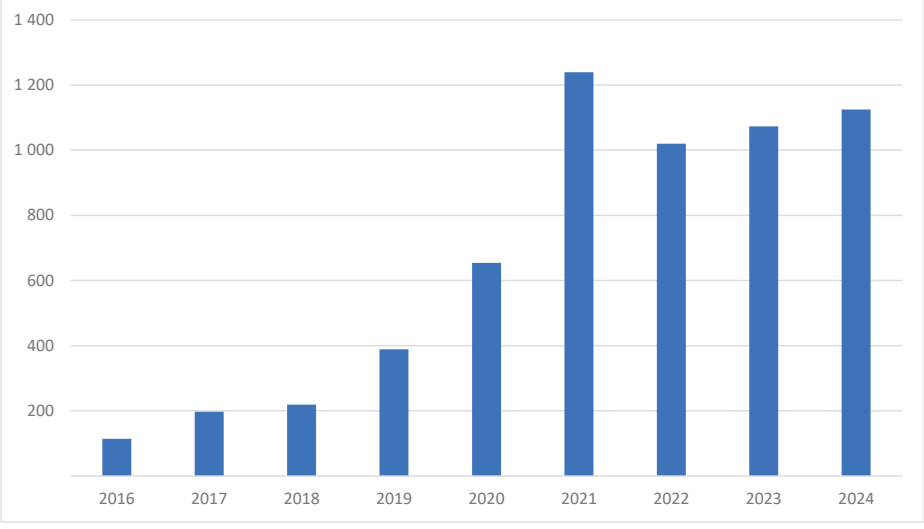

Fig. 2. **Issuance of Bonds within the Global Sustainable Finance Market, USD Billion**

Source: compiled by the author based on: URL: https://thedocs.worldbank.org/en/doc/cd82b4033281dab2cb1a1c71eeb691e4–0340012025/original/Labeled-Bond-Quarterly-Newsletter-Issue-No-10.pdf

development segment is becoming increasingly important. The Bank of Russia is capable of creating regulatory incentives to achieve sustainable development goals and emphasizes the importance of utilizing market participants' potential to finance sustainable development projects.[4] Regulation of credit institutions is essential for involving them in the financing of sustainable projects and for developing markets for instruments related to this agenda.

Prudential regulatory measures play a key role in addressing these objectives and have a positive effect on the growth rate of green lending [10]. Lower risk weights applied to relevant loans and bonds reduce the capital burden on banks [11].

Currently, the Bank of Russia implements incentive-based regulatory measures for projects aimed at achieving technological sovereignty and adapting the economy to new conditions. According to its estimates, the effect of these measures may amount to between 10% and 70% of the standard credit risk level for a loan.[5]

Applying reduced risk weights to loans and bonds issued to attract long-term financing for sustainable projects will increase their attractiveness for credit institutions and create additional incentives for new participants to enter the market. Prudential regulation, combined with general fiscal policy measures and targeted state support instruments, will strengthen the overall stimulative impact of the measures being implemented.

An important area of support for the structural transformation of the Russian economy is state subsidization of interest rates on loans and bonds within the sustainable development segment. This mechanism will provide companies with additional incentives to develop their businesses on the basis of sustainable finance and will mitigate the negative impact of external and internal factors on sustainable development instruments for both issuers and investors.

A key stage in issuing such instruments is their independent verification, which confirms the compliance of projects with international and Russian sustainable development principles. National rating agencies act as verifiers. Government compensation of expenses associated with this procedure would help attract issuers and facilitate the implementation of new projects.

It is crucial to ensure transparency and accessibility of non-financial information on sustainable development [12]. This will enable creditors, shareholders, consumers, and regulatory authori-

[4] URL: https://www.cbr.ru/Crosscut/LawActs/File/6233

[5] URL: https://www.cbr.ru/Content/Document/File/160494/dbra_20240417.pdf

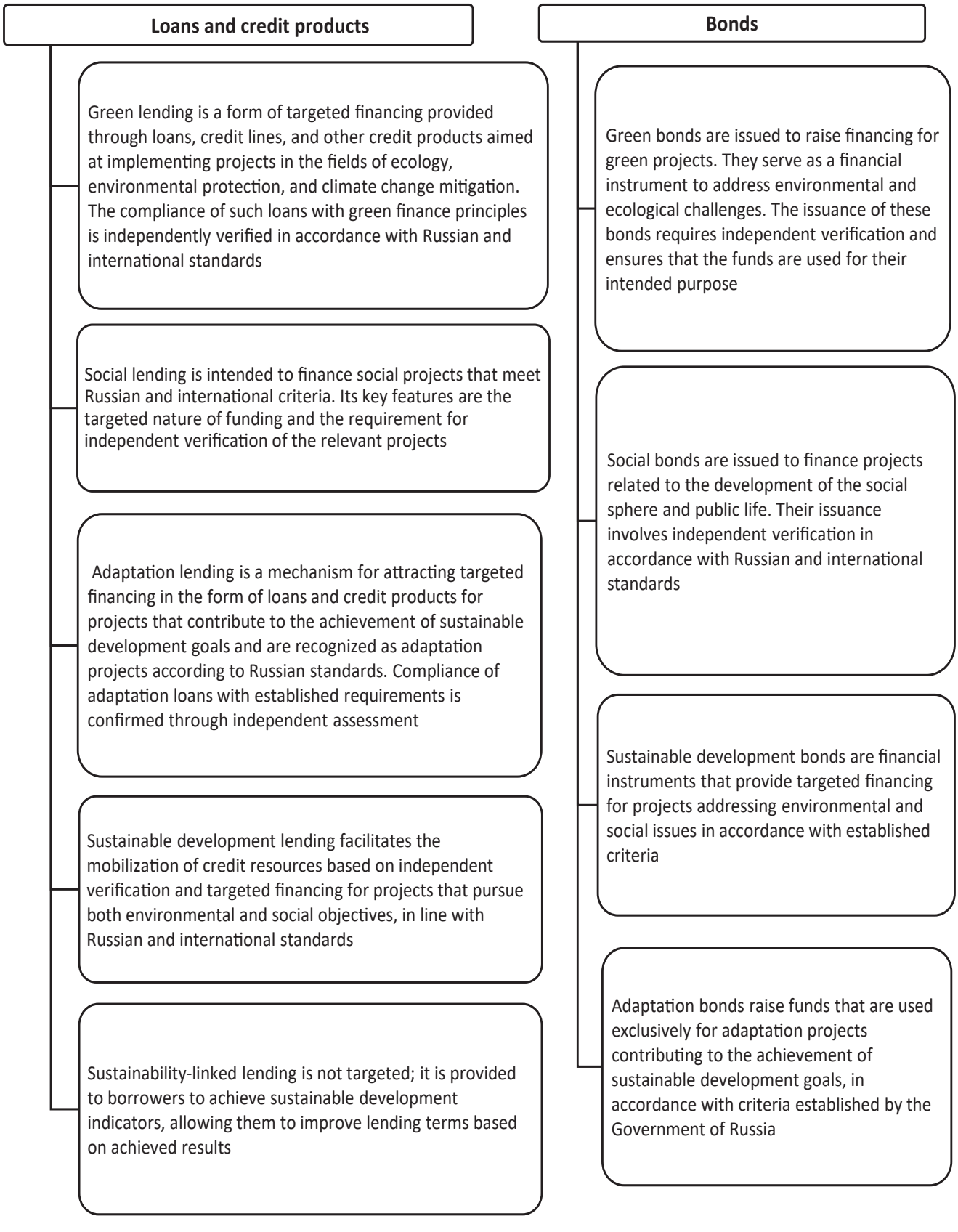

Fig. 3. **Main Financial Instruments for Sustainable Development on the Russian Financial Market**

Source: compiled by the author.

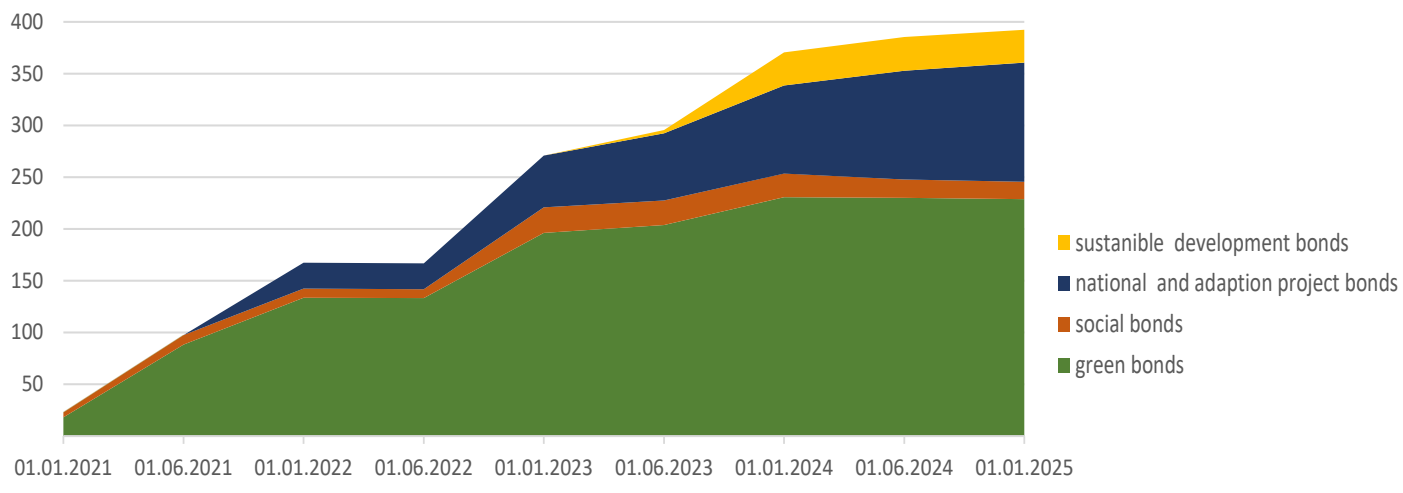

Fig. 4. **Volume and Structure of the Russian Market for Bonds Supporting Sustainable Development, RUB Billion**

Source: compiled by the author based on Bank of Russia data URL: https://www.cbr.ru/vfs/statistics/debt_securities/71-debt_securities.xlsx

ties to gain a comprehensive understanding of a company's activities and development prospects, thereby contributing to the attraction of external financing. Improving the quality and availability of non-financial information is also important for integrating sustainable development goals into the business models of Russian companies. The timely disclosure of such reports will allow market participants to better assess borrowers' risks and compare them when making investment decisions.

Non-financial information in the field of sustainable development is also essential for the pricing of loans and bonds linked to these goals. It helps assess companies' contributions to social development and environmental protection and ensures the effective functioning of financial markets [13].

The system for disclosing non-financial information in Russia, the content of which is currently determined by issuers, is still under development. The Moscow Exchange has established requirements for companies whose shares are included in the First and Second Listing Tiers. The Bank of Russia has developed recommendations regarding the disclosure of non-financial information by credit institutions and their clients in relation to the achievement of sustainable development goals.

To expand the ability of financial market participants to account for sustainable development objectives, it is necessary to adopt a mandatory standard for non-financial information disclosure. This is important so that participants can evaluate companies' performance in this area and identify risks associated with environmental and social factors. Ensuring the reliability of disclosed information requires its certification by auditing firms.

Trust is crucial for investment horizons and for attracting private investors to projects that consider sustainable development goals [14]. The adoption of a Russian standard for non-financial information disclosure will help strengthen trust in companies among investors, clients, employees, and other stakeholders. Non-financial information certified by auditing firms is one of the key conditions for ensuring transparency in the use of state support mechanisms and the participation of development institutions in projects.

An important element of regulation in the field of sustainable development is the system for accounting and trading Russian carbon units[6]: the number of such units within a project allows the

[6] Carbon units refer to verified decreases in carbon emissions resulting from environmental projects.

company's contribution to the structural transformation of the Russian economy to be assessed.

Carbon markets represent a mechanism of sustainable finance that motivates economic actors to reduce carbon emissions and finance "green" projects [15]. Companies implementing green projects generate carbon units, which can be sold to market participants responsible for carbon emissions.

Based on current regulatory practices in developed and developing countries, carbon markets can be divided into regulated and voluntary segments (see *Fig. 5*). At present, these segments are weakly interconnected, as organizations that purchase carbon units on voluntary markets are unable to use them to offset mandatory payments to the state for exceeding carbon emission limits.

The voluntary carbon market established in Russia allows economic actors to conduct transactions with carbon units, while companies can acquire them to implement policies aligned with sustainable development goals. The registry of JSC Kontur currently lists 40 climate projects and over 32 million carbon units in circulation.[7]

At present, Russia is in the process of creating a mandatory carbon market based on an experimental program,[8] which aims to achieve carbon neutrality in the Sakhalin region by the end of 2025. Expanding this experience to other regions and sectors will involve setting quotas and introducing a carbon tax for companies responsible for emissions.

The theoretical foundation of carbon taxation is provided by A. Pigou, who justified its necessity in relation to activities that generate negative externalities, including environmental pollution [16]. A carbon tax, taking into account country-specific conditions, is an important tool for achieving carbon neutrality and improving environmental outcomes. Carbon taxation, combined with innovation and digitalization, contributes to the achievement of sustainable development goals by reducing harmful emissions [17].

The carbon regulation system also serves as a source of financing for environmental programs. By the end of 2023, the total global volume of payments

The launch of this system will increase demand for carbon units and create additional incentives for the implementation of green projects, while state support measures will facilitate the generation of carbon units.

Public-private partnership mechanisms can accelerate the structural transformation of the Russian economy in line with the sustainable development agenda and expand the investor base for projects that consider social and environmental priorities. The experience gained through such partnerships will help improve the effectiveness of state support instruments. A crucial condition for attracting private investors to projects is ensuring the stability of regulatory and financial conditions in place at the time of transaction, as well as expanding the use of state guarantees.

Incorporating social factors at both the governmental and corporate levels will create favorable conditions for developing an inclusive economic model and provide Russian companies with new competitive advantages by enhancing the management of reputational risks and expanding cooperation with regulatory authorities.

The creative industries play a key role in the social dimension of sustainable development, acting as an important driver of human capital growth, export potential, and employment. Their main characteristic is the production of innovative and intellectual products based on the creative potential of employees [18]. The implementation of creative projects simultaneously generates consumer-demanded creative products and creates synergistic effects within the economy.

The transformation of the Russian economy based on sustainable development goals entails increasing its scientific and educational potential. In this context, the creative industries become a public good, as many products they produce for individual consumers are also accessible to other economic actors without additional costs.

The expansion of digital platform businesses is one of the most important trends in the develop-

[7] URL: https://carbonreg.ru/ru/

[8] URL: https://www.consultant.ru/document/cons_doc_LAW_411051/

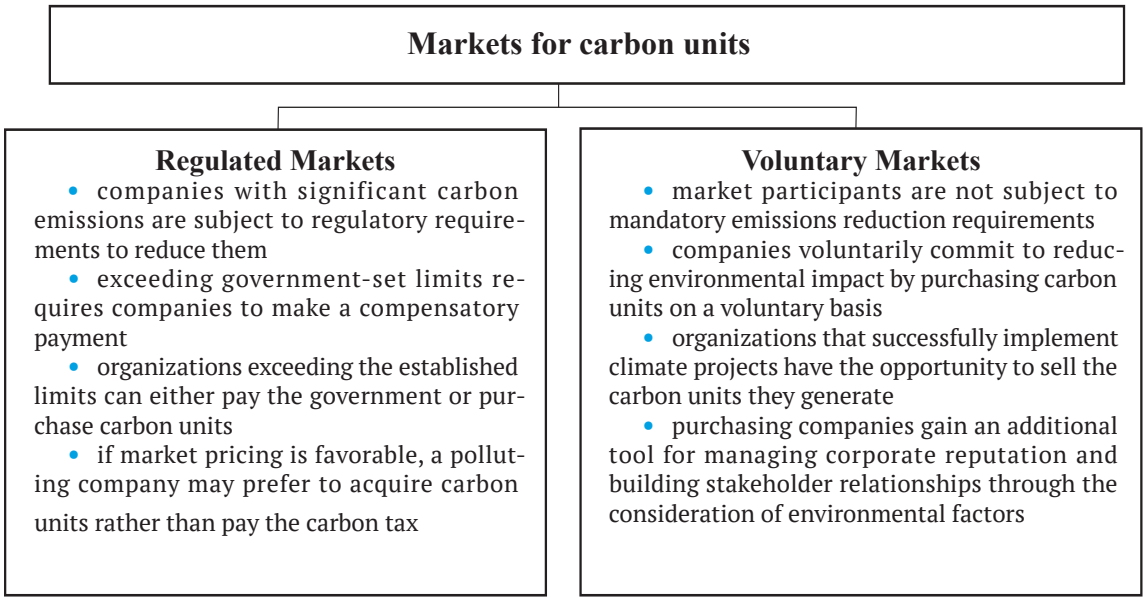

Fig. 5. **Structure of Carbon Unit Markets**

Source: compiled by the author.

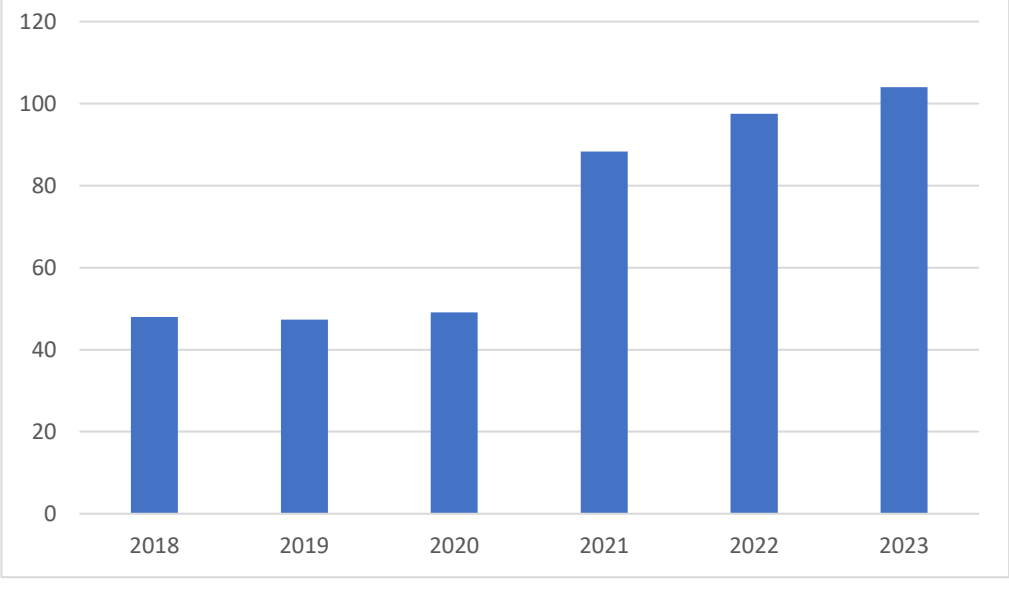

Fig. 6. **Volume of Carbon Emissions Payments, USD Billion**

Source: compiled by the author based on: URL: https://carbonpricingdashboard.worldbank.org/compliance/revenue

ment of the Russian economy, as they create new opportunities for promoting products and services of credit institutions, while creative content helps attract new clients to these platforms. In this way, they complement each other and generate synergistic effects.

The development of creative industries allows for the creation of new jobs and the implementation of innovations, which is particularly important for the growth of small and medium-sized enterprises, linking the social sphere, business, and government.

The creative economy possesses significant innovative potential and the capacity to produce intellectual products with high added value. Creative industries also have substantial opportunities to expand exports, which does not require major infrastructure investments, since many products

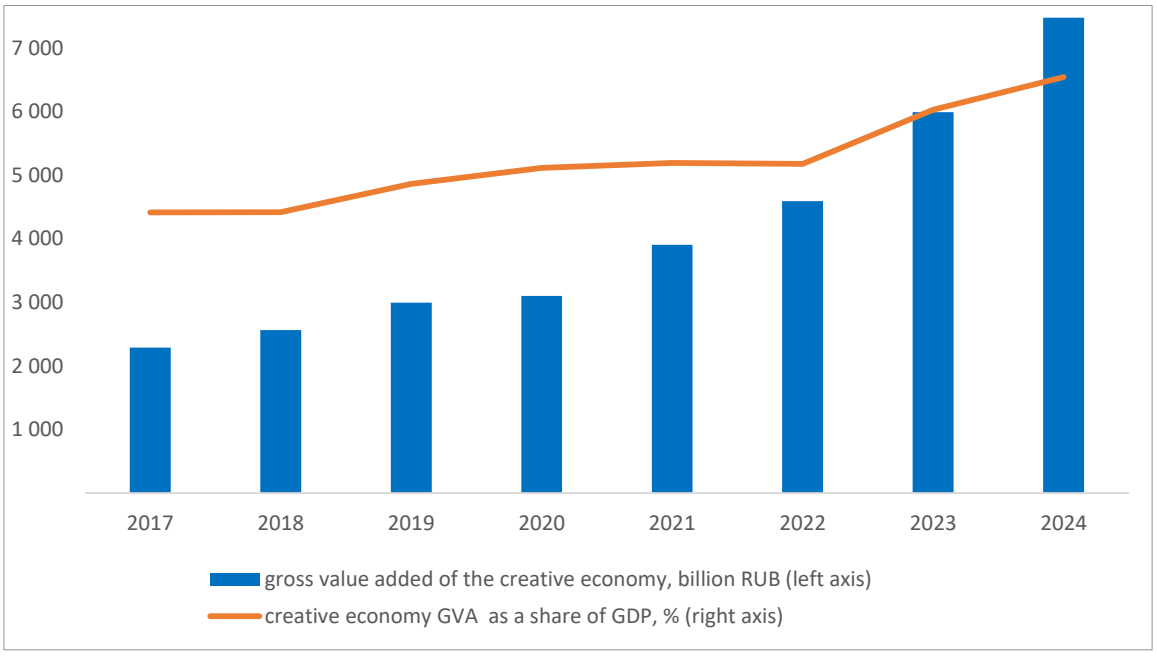

Fig. 7. **Development of the Creative Economy in Russia**

Source: compiled by the author based on: URL: https://rosstat.gov.ru/storage/mediabank/VDS_ce-OKVED2_VVP.xlsx

are created in digital format and can be distributed through remote sales channels. At the same time, there are prospects for further development, which necessitate strengthened cooperation among the government, business, and cultural, scientific, and educational institutions (see *Fig. 7*).

Domestic companies possess significant potential for implementing digital technologies necessary for the development and promotion of the outputs of creative industries, which, however, still require state support in the context of a substantial increase in interest rates in the Russian credit market and the limited lending capacity of banks.

Support measures implemented at the federal and regional levels should help eliminate barriers that hinder the development of the creative economy, including:

- insufficient financial resources at the early stages of creative companies' operations;
- infrastructure limitations;
- a shortage of skilled personnel;
- difficulties in promoting creative products;
- underutilization of existing human capital [19].

Addressing these challenges requires both general fiscal policy measures (such as further increases in budget spending on education, science, and culture) and targeted instruments of state support. Budgetary financing should ensure the training of personnel for the creative economy and the development of specialists' creative potential.

Currently, investment in research and development (R&D) does not correspond to the objectives of transforming the Russian economy toward sustainable development and enhancing the potential of creative industries (see *Fig. 8*). Based on the experience of developed countries, it is important to increase R&D expenditures to 3% of GDP through improved mechanisms of cooperation between the state and business [20], which is necessary due to the high level of state involvement in the Russian economy and the limited capacity of private companies under adverse external and internal conditions.

Targeted support measures for the creative economy within the framework of sustainable development should help overcome institutional and infrastructural constraints in this sector. To achieve this, it is important to activate mechanisms at the federal and regional levels for providing grant support to creative teams at the

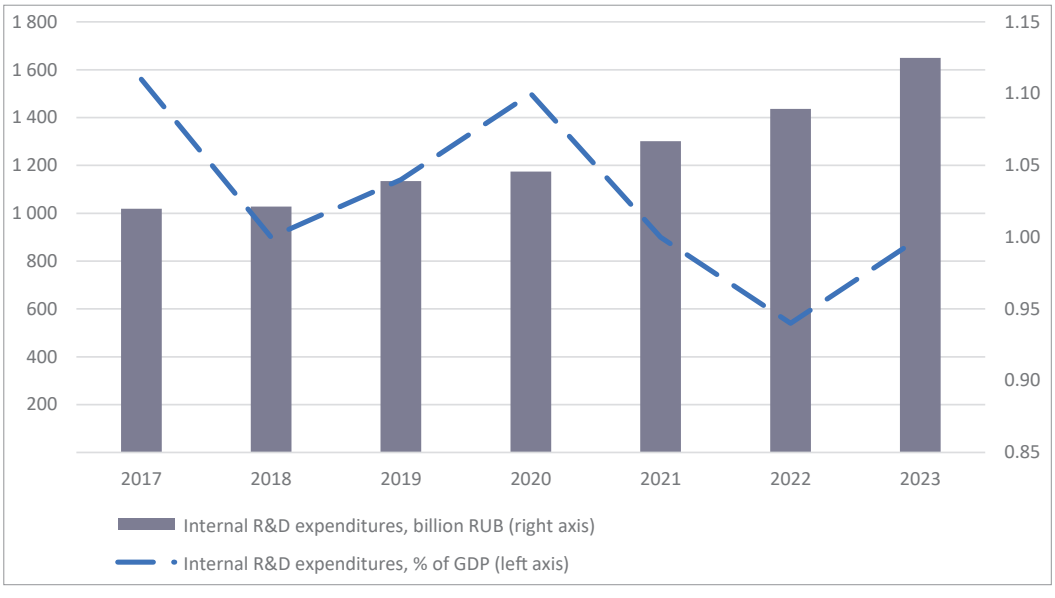

Fig. 8. **Domestic R&D Expenditures in Russia [in RUB Billion and % of GDP)**

Source: compiled by the author based on: URL: https://rosstat.gov.ru/storage/mediabank/nauka_5.xlsx

early stages of their activities. In particular, the following instruments appear to be appropriate:

- provision of grants, which will help alleviate challenges related to accessing financing;
- consideration of the specific characteristics of creative companies when developing support programs for small and medium-sized enterprises;
- creation of conditions for the promotion and sale of creative products through state compensation of expenses associated with participation in exhibitions and promotion on platforms and ecosystems;
- use of preferential lending programs and partial compensation of costs for acquiring equipment necessary for producing creative products;
- establishment of incentives to strengthen cooperation between educational institutions and the creative sector;
- partial compensation of training costs for employees of creative companies.

The creation of new infrastructural opportunities for the development of creative companies requires the coordinated efforts of businesses, regional authorities, and federal government bodies to establish new clusters based on public-private partnerships. Such partnerships involve attracting private investors, financing projects through development institutions, and utilizing co-financing mechanisms provided by the state.

A key role in consolidating the efforts of market participants is played by the state corporation VEB.RF, which ensures the coordination and management of Russian development institutions to create favorable conditions for economic growth, the implementation of innovations, infrastructure projects, increased exports, the development of small and medium-sized enterprises, and the promotion of the sustainable development agenda.

VEB.RF possesses financial products crucial for the development of the sustainable creative economy, including instruments for supporting small and medium-sized enterprises, Russian exports, and public-private partnership projects, as well as preferential lending programs.

Creative clusters are complexes in which companies in this sector conduct their activities. Expanding the network of such clusters will enhance the efficiency of interaction among scientific and educational institutions, creative companies, the state, and consumers. In the context of accelerated innovation, mechanisms for cooperation among the government, society, and the corporate sector are of key importance for economic transformation [21].

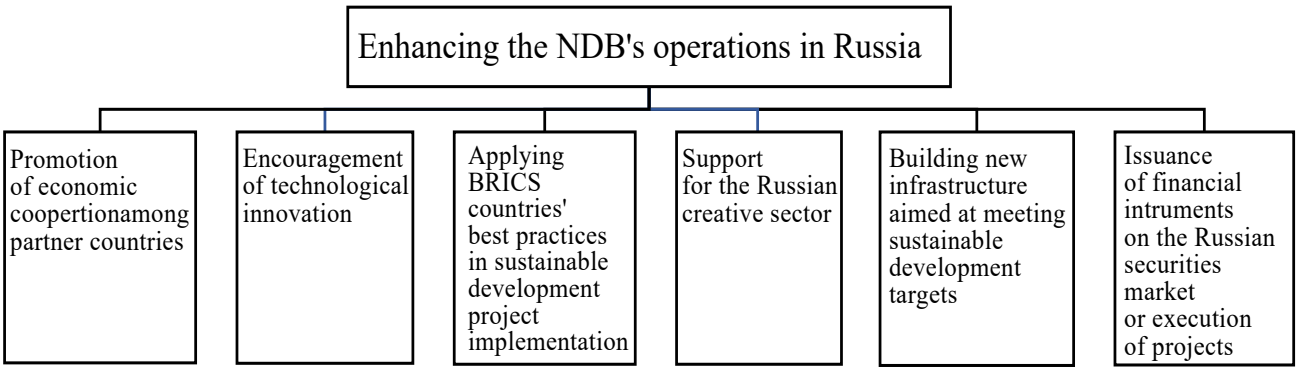

Fig. 9. **Utilizing the Potential of the BRICS NDB for the Sustainable Transformation of the Russian Economy**

Source: compiled by the author.

State investments in the creation of creative clusters will contribute to the formation of new value chains and attract additional participants to the sector. The development of creative clusters is also important for adapting state support instruments to remove informational barriers, organize creative spaces, develop high value-added innovative products, foster the emergence of new high-tech companies, and increase the export potential of innovative industries.

Given the vital role of the creative sector in transforming the economy toward sustainable development, it is important to establish a governmental body responsible for interdepartmental cooperation and coordination of efforts among the Russian Government, regional authorities, and development institutions.

FORMING THE SUSTAINABLE DEVELOPMENT AGENDA WITHIN BRICS

Expanding cooperation with BRICS countries in the field of sustainable development will allow Russian companies to attract additional investment, enter new markets, and implement joint projects in this area. The formation of a common agenda will be facilitated by mutual recognition of sustainability ratings (currently, differences in methodologies hinder their comparability and use), creating additional opportunities for Russian companies to access BRICS markets.

To align the sustainable development policies of member countries, coordination of approaches in assessing climate risks and regulating the issuance of necessary debt instruments is essential. Attracting investors from friendly countries to the Russian financial market will support the mutual recognition of sustainability reporting by issuers of sustainable bonds.

Leveraging the opportunities provided by the New Development Bank (NDB) of BRICS is important for creating conditions for the growth of the Russian economy within a sustainable development model (see *Fig. 9*). NDB investments will help consolidate the efforts of Russian companies, banks, and organizations from friendly countries to finance projects in renewable energy, environmental protection, digital transformation, and social infrastructure. Expanding the NDB's activities in Russia will increase demand for the Russian financial market and raise the volume of sustainable development instruments in circulation.

The development of a unified BRICS taxonomy for sustainable development projects and the mutual recognition of national taxonomies in this field will create conditions for attracting investment to the Russian economy and improve the quality of project evaluation and their impact on environmental and social outcomes. China, Russia, and South Africa have adopted corresponding taxonomies, while India and Brazil are in the process of approval.

A unified taxonomy is also important for regulators to provide state support based on compliance with sustainability criteria. In its development, it is necessary to consider the successful

experience of project implementation in BRICS countries and harmonize approaches to non-financial information disclosure. This will enhance the transparency of sustainable finance and increase the potential for attracting private investment.

An important area of cooperation within BRICS is the harmonization of carbon markets, which are still in the early stages of development. China is the leader in this area, using its carbon market as one of the tools for achieving carbon neutrality. Differences in approaches prevent economic actors from fully exploiting opportunities for cooperation in this field, resulting in the inability to trade carbon units due to the lack of mechanisms for mutual recognition.

A common agenda will enable the creation of a unified BRICS carbon market. Russian companies have significant capabilities in generating carbon units, experience in issuing them in accordance with Russian standards, and in trading with foreign buyers. Consequently, their sale to organizations in member countries will promote the development of sustainable finance and attract funding for new projects.

The financial infrastructure of the BRICS carbon market should be based on the use of national currencies for settlements, which will reduce the adverse impact of geopolitical factors on the development of sustainable finance. Another important area is the possibility of using highly liquid crypto-assets, particularly Bitcoin and Ethereum, for transactions. In the medium term, the issuance of central bank digital currencies by BRICS countries will allow their use in settlements. The application of digital technologies will enhance the resilience, transparency, and security of the financial infrastructure.

Significant opportunities for BRICS countries to jointly promote the sustainable development agenda lie within the creative economy. Collaborative projects among economic actors from member states will help establish value creation chains in key sectors of the economy from a sustainable development perspective, as well as create new opportunities for cooperation in culture, environmental protection, science, and education.

A key task is state support for the cooperation of Russian creative clusters with counterparts in the creative economies of BRICS countries. The foundation for this development is the exchange of experience in successfully operating creative businesses that align with sustainable development goals. Strengthening collaboration in this area involves the implementation of joint scientific, educational, and project initiatives, facilitated by financing from the NDB and Russian development institutions.

The development of creative industries implies enhancing their export potential and ensuring the long-term presence of Russian companies in the markets of friendly countries. This requires extending existing state support measures for Russian exports to companies in the creative sector. The growth of the Russian economy in this area will increase its attractiveness to investors from friendly countries and expand companies' export opportunities. In the longer term, the creation of joint products will help form a shared BRICS creative space based on innovation, utilization of scientific and educational potential, knowledge exchange, creation and preservation of cultural values, and addressing environmental challenges.

CONCLUSION

The structural transformation of the Russian economy entails the formation of a new model of sustainable economic development, based on responsible business practices, innovation, social equity, the development of citizens' creative potential, and the preservation of a favorable environmental situation.

A crucial condition for the transition of the Russian economy to a sustainable development model is the accelerated growth of creative industries. This requires both general fiscal policy measures and targeted support instruments for creative companies. The study emphasizes the importance of consolidating the efforts of the state, business, and scientific and educational institutions.

Accelerating the structural transformation of the Russian economy in line with sustainable development goals involves the use of financial support mechanisms, including the application of reduced risk weights for loans and bonds, as determined by the Bank of Russia; subsidization of interest rates on loans and bonds; and compensation of expenses

for project verification in this field. The expansion of state support practices entails linking them to achieved results, sustainability ratings, and credit ratings, as well as ensuring informational transparency through the implementation of Russian standards for non-financial information disclosure in this area. The use of public-private partnership mechanisms will attract private investors to projects and help achieve social and environmental objectives in their implementation.

The carbon regulation system is a key element of the emerging sustainable development economy in Russia. The launch of a mandatory carbon market segment and the introduction of a carbon tax will facilitate investment in green projects.

The formation of a common BRICS sustainable development agenda will be supported by the mutual recognition of sustainability ratings and national taxonomies in this field, the adoption of a unified taxonomy for sustainable development projects, and the harmonization of approaches to managing climate risks and regulating bond markets. In this context, the participation of the NDB in Russian projects is crucial for fostering cooperation with friendly countries.

The improvement of the national carbon market and its harmonization with the markets of BRICS member countries will contribute to the structural transformation of the Russian economy based on sustainable development goals. A key task is the recognition of Russian carbon units in BRICS countries and the possibility of their sale to counterparties in friendly states. The financial infrastructure of the carbon markets in member countries should be built on a broad set of settlement options, including traditional mechanisms using national currencies, private crypto-assets, and central bank digital currencies of the Union.

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Consumer Choice Features in the Context of Bounded Rationality and the Influence of Artificial Intelligence

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ABSTRACT

Subject. This article examines the impact of bounded rationality on consumer behavior and how modern artificial intelligence (AI) technologies are transforming economic decision-making processes. The purpose of the study is to demonstrate how human cognitive and time limitations, combined with algorithmic recommendation systems, dynamic pricing, and other AI tools, shape a new environment for making choices. The scientific significance of the research lies in the expansion of the classical «rational agent» model by integrating psychological factors and considering the risk of manipulative potential inherent in AI. The methodological foundation includes works on behavioral economics, the concept of bounded rationality, as well as contemporary studies focused on the application of machine learning and big data analytics in markets for goods, services, and financial products. A comparative analysis of theoretical models is also employed, along with practical case studies from e-commerce, travel services, and robo-advisors. The practical significance of the article lies in the potential to help companies, regulators, and consumers interact more effectively and transparently in the digital economy, taking into account both the benefits and potential risks of algorithmic technologies.

Keywords: bounded rationality; artificial intelligence; behavioral economics; dynamic pricing; cognitive biases; personalized recommendations; digital economy

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INTRODUCTION

The modern economic landscape is rapidly evolving under the influence of digital technologies, which are increasingly permeating both everyday life and professional activities. Algorithms with varying degrees of "intelligence" are now used across almost all areas of economic activity — from e-commerce and automated financial market analysis systems to marketing campaigns powered by cognitive computing. At the same time, classical economic concepts — in particular, the "rational agent" model (Homo Economicus), which assumes that individuals maximize their own interests with full knowledge of available choices — do not always adequately describe actual consumer behavior. In reality, people are often guided by emotions, subject to various cognitive biases, and constrained by limited time and resources.

The concept of bounded rationality, proposed by H. Simon, has long been a central focus of behavioral economics, which seeks to explain why people do not always make "optimal" decisions. Today, with the addition of powerful AI tools to the existing sources of uncertainty, this issue has become even more pressing. On one hand, algorithmic systems can help consumers find desired goods or services more quickly by analyzing vast amounts of data in fractions of a second; on the other hand, they often exploit behavioral vulnerabilities, creating nudges that encourage unconscious or emotionally driven choices. As a result, the question of the synergy between "bounded rationality + AI" has gained particular significance, as it determines whether modern consumers will reap benefits — such as time savings and expanded choices — or be subtly manipulated by systems that exploit their cognitive weaknesses.

If you want, I can also help make this introduction even more fluid and journal-ready for an academic or professional audience, emphasizing clarity and style. Do you want me to do that?

An equally significant role is played by the socio-economic context in which both consumers and suppliers operate. In the digital economy, communication and sales channels themselves are changing: marketplaces, mobile applications, and online platforms are increasingly implementing machine learning systems and big data analytics. Moreover, competition for users' attention is intensifying, so platforms actively use recommendation algorithms to boost sales and retain audiences. These algorithms can be tailored to identify each customer's "pain points" and preferences, then offer personalized discounts or products, thereby increasing the likelihood of impulsive spending. At the same time, the question of ethical boundaries for such personalization, as well as the need for regulatory standards to prevent harmful or discriminatory practices, remains unresolved.

In light of the above, it is important to examine how individuals' bounded rationality manifests in the modern digital environment and how artificial intelligence technologies modify the economic decision-making process. Particular emphasis is placed on analyzing both the positive effects, such as the reduction of temporal and informational barriers, and the negative consequences that arise when algorithms are used manipulatively for the benefit of specific organizations.

THEORETICAL FOUNDATIONS: BOUNDED RATIONALITY AND THE BEHAVIORAL TURN IN ECONOMICS

For a long time, traditional and especially neoclassical economic schools relied on the postulate that people behave rationally, seeking to maximize utility when making decisions. However, as early as the mid-20th century, Herbert Simon demonstrated that, in real life, economic agents have highly limited resources for processing information and are prone to perceptual and evaluative errors [1]. According to the concept of bounded rationality, an individual tends to seek a "satisficing" solution rather than an ideal optimization. This idea became the foundation of modern behavioral economics, whose proponents (Kahneman, Tversky, Thaler, and others) empirically demonstrated the existence of a

wide range of cognitive biases that influence behavior [2–5].

For example, the anchoring effect occurs when the first observed price or number influences all subsequent judgments, while confirmation bias reflects the tendency to actively seek information that aligns with existing beliefs [4, 5]. Collectively, these biases limit the ability to impartially compare alternatives and choose the truly optimal option. In a digital society, such biases can not only persist but also intensify through more subtle mechanisms of targeted influence [6].

In the Russian academic context, these issues are reflected in studies of behavioral models and various forms of "digital" socialization of consumers [7,8]. Scholars also note that a specific combination of historical, social, and psychological factors can either amplify or mitigate certain forms of irrational behavior. Nevertheless, the overall conclusion remains unchanged: the Homo Economicus model only partially describes reality, as individuals are limited by their cognitive capacities and are constantly subject to effects that do not conform to the classical logic of absolute rationality.

The "behavioral turn" in economics essentially broadens the analytical framework by integrating methodologies from psychology, sociology, and neuroscience. This research approach allows for a deeper understanding of how people make decisions, how preferences are formed, and how social institutions can either mitigate behavioral vulnerabilities or, conversely, exploit them for self-interested purposes. These effects are most pronounced in digital environments, where AI enables content to be tailored to individual users and their reactions tracked almost in real time.

Thus, the theoretical foundation of this study is based on the concept of bounded rationality, supported by extensive empirical evidence from behavioral economics, as well as numerous studies by domestic and international scholars examining the manipulation of consumer behavior through digital platforms.

ARTIFICIAL INTELLIGENCE TOOLS: PERSONALIZATION, PRICING, AND CHOICE ARCHITECTURE

Modern AI technologies go far beyond simple sorting or recommendation algorithms: they consist of complex machine learning systems capable of analyzing massive datasets (big data) while accounting for temporal trends, geolocation, psychological preferences, and numerous other factors. In the context of consumer choice, several key applications of such tools can be highlighted. Recommendation systems have become an integral part of many online platforms, from e-commerce sites to streaming services. Algorithms based on collaborative filtering suggest products, movies, music, and other items according to the user's previous actions. On one hand, this significantly simplifies information search and reduces time costs; on the other hand, it creates a "filter bubble," where the consumer sees only a narrow selection curated by the algorithm, losing opportunities for serendipitous discovery.

Under conditions of bounded rationality, recommendation systems can exploit anchoring or scarcity effects, for example, by showing how many items are left in stock and emphasizing urgency. A customer busy with daily tasks often does not consider whether these "remaining quantities" are real or artificially generated. While such tactics increase conversion rates, they raise ethical concerns regarding the methods of influence.

Another important AI tool is dynamic pricing, widely used in travel and transportation services (airline bookings, hotel reservations, taxis, etc.). Algorithms monitor demand, seasonality, competitor behavior, and even individual factors, such as a user's search history for specific routes. If the system notices that a user repeatedly revisits the same itinerary, the price may rise. This strategy encourages quick decision-making, as the fear of missing out (FOMO) drives immediate action.

From a classical economic perspective, a changing price is dynamically fair, as it reflects the real-time balance of supply and demand. In practice, however, consumers experience additional stress: they may feel "cornered into a purchase," fearing

further price increases. Thus, bounded rationality manifests in a tendency toward hasty actions initiated by the algorithm [10, p. 125].

In behavioral economics, the concept of choice architecture has long been recognized [11], where the environment in which an individual makes decisions is deliberately structured to nudge them toward certain actions. Digital platforms expand this idea by creating interfaces that can amplify irrational impulses. For example, pop-up notifications, countdown timers, bright color accents, and sound cues can focus the user's attention on a target action — most often a purchase or subscription — while ignoring alternatives.

AI algorithms track the effectiveness of such nudges for each audience in real time, making rapid adjustments. If a particular user group is more prone to impulsive decisions, the system can increase the frequency of promotions or notifications, encouraging additional transactions. From a business efficiency standpoint, this is beneficial, but for consumers, it carries the risk of unwanted spending.

Marketing has long used segmentation based on socio-demographic and behavioral criteria. However, with modern machine learning algorithms and big data analysis, companies can identify subtle psychological traits of their audiences — even detecting emotional patterns and a user's current mood. Dynamic offers can then be tailored to the individual (for example, based on the time of day or previous actions), presenting "comfort purchases" or "inspirational" deals, which intensifies the impact on emotions and bounded rationality. Practical applications of these AI tools span many domains. Some of the clearest examples demonstrate how digital technologies interact with consumer bounded rationality.

In e-commerce giants like Amazon, Ozon, and Wildberries, recommendation algorithms create personalized storefronts: users are shown products based on their search history, previous purchases, and browsing behavior. On one hand, this saves significant time, as the customer does not need to sift through thousands of items manually. On the other hand, it creates the illusion of the "best deal" or "most popular" option, which limits real freedom of choice. Often, people buy exactly what the system highlights without exploring the market more thoroughly.

In addition, marketplaces employ social proof tactics (for example, displaying the number of positive reviews) and scarcity cues (highlighting that a product is "running out"). Consumers tend to respond to these signals emotionally, making decisions under the influence of fear of missing out (FOMO). In this way, bounded rationality nudges individuals to avoid spending time on additional comparisons and to purchase the product "here and now."

Well-known services such as Booking.com, Airbnb, and Skyscanner implement dynamic pricing, where costs can change literally within minutes. Furthermore, platforms actively use informational cues indicating how many people are "currently" viewing the same dates or how quickly rooms in a selected hotel are being booked. Seeing growing demand, users often perceive the situation as a competition for a limited resource and make decisions under pressure. As a result, purchases may occur faster than if the person had time to calmly weigh the pros and cons. In the digital economy, such practices are increasingly perceived as the norm, yet questions regarding the ethical boundaries of these strategies remain unresolved.

Robotic investment advisors, which have become increasingly popular, offer clients automatically generated securities portfolios based on questionnaires and big data analysis. These services promise to simplify investing, making it accessible to a broader population. However, the actual effectiveness of such "robo-advising" can heavily depend on the assumptions built into the algorithm. Individuals with limited knowledge of financial markets, influenced by marketing promises, often overestimate the algorithm's capabilities and underestimate market risks. Moreover, the algorithm frequently does not account for an investor's unique life circumstances, such as the need for liquid funds or unexpected expenses.

Overall, these cases demonstrate that the interaction between AI and bounded rationality can have both positive effects (time savings, personalized assistance) and negative effects (manipulation, imposed decisions). It is crucial to consider these processes alongside ethical and legal aspects, as the boundaries of acceptable algorithmic influence on human choice are not always clear [9–11].

ETHICAL CHALLENGES AND LEGAL REGULATION

The active use of AI in marketing and sales raises a number of ethical concerns, the foremost of which is transparency in user interactions. Companies can collect and process vast amounts of data — including information not explicitly provided by the consumer — create behavioral profiles without direct consent, and use the results of such analyses to nudge users toward purchases. Considering that individuals are often unaware of the mechanisms behind dynamic pricing or recommendation systems, there is a significant risk of manipulation and the amplification of existing cognitive biases.

In both the **Russian legal framework** and internationally, increasing attention is being paid to the principles of fair data processing and the need to inform users. Key aspects include:

Privacy and personal data protection[1]. The Russian Federal Law "On Personal Data" imposes restrictions on the collection, storage, and transfer of information that can identify an individual. In the European Union, Regulation (EU) 2016/679[2] (General Data Protection Regulation, GDPR) establishes similar principles. However, in the context of machine learning, it is often difficult to determine precisely which data were used by an algorithm and how the final decision is generated.

Prevention of discrimination and exploitation of vulnerable groups. Algorithms trained on "historical" data may implicitly inherit biases. This can lead to segregation based on income, age, or other factors, with certain user groups systematically shown inflated prices or denied access to important alternatives. Discriminatory practices in the market for goods and services are prohibited by various regulations (including the Law on Advertising[3]), yet their adaptation to digital platforms remains incomplete.

Informed consent and algorithmic transparency. The principle of transparency means that users have the right to know how recommendations and prices are calculated, and whether factors such as their geolocation and search history are considered. However, questions remain about how deeply and in what format such details should be disclosed. Overly detailed explanations may encourage users to bypass algorithmic restrictions, while insufficient information increases the risk of manipulation and undermines trust.

At the international level, comprehensive ethical and legal standards for AI are being developed. For example, the OECD AI Principles[4] emphasize the importance of transparency and accountability for developers. In 2021, UNESCO adopted the "Recommendations on the Ethics of Artificial Intelligence[5]," aimed at protecting human rights and individual dignity. The European Union is also developing the Artificial Intelligence Act[6], which seeks to systematize risks and establish requirements for specific categories of AI systems.

In Russia, there have been growing calls for the development of codes of ethics for AI system developers and operators, as well as for the creation of independent algorithm audit institutions [12] capable of verifying whether systems violate fair competition rules, employ dark patterns, or contain discriminatory elements. While traditional marketing has been regulated through advertising standards and antitrust laws, artificial intelligence requires more sophisticated control tools that take into account the algorithmic nature of decision-making and the challenges of the "black

[1] URL: https://www.consultant.ru/document/cons_doc_LAW_61801/

[2] URL: https://eur-lex.europa.eu/EN/legal-content/summary/general-data-protection-regulation-gdpr.html

[3] URL: https://www.consultant.ru/document/cons_doc_LAW_58968/

[4] URL: https://www.oecd.org/en/publications/artificial-intelligence-in-society_eedfee77-en.html

[5] URL: https://www.unesco.org/en/articles/recommendation-ethics-artificial-intelligence

[6] URL: https://data-en-maatschappij.ai/en/publications/europese-commissie-proposal-for-a-regulation-laying-down-harmonised-rules-on-artificial-intelligence

box." Moreover, several researchers emphasize the importance of Explainable AI (XAI), which would provide a comprehensible justification for algorithmic decisions [13]. This is particularly crucial in cases where algorithms nudge consumers toward specific behaviors based on data and patterns hidden from them. Without clear explanations, consumers — already operating under conditions of bounded rationality — become even more vulnerable to manipulative practices.

Independent audits can reveal hidden exploitation of cognitive biases and systematic overpricing for certain groups. Explainable AI plays a central role here, as it allows the system to present the logic behind its recommendations or evaluations in a way understandable to both regulators and users.

Meanwhile the following measures are being discussed:

- *Disclosure of key pricing factors*, for instance, when a platform informs users that product prices depend on location or browsing history.
- *Prohibition of aggressive targeting of vulnerable groups*, which entails stricter monitoring of offers aimed at users with low income, signs of addiction, or other social vulnerabilities.
- *Liability for deliberate misinformation*, meaning that companies repeatedly misleading users through variable algorithms could face fines and sanctions from regulators.

It should be noted that finding a balance between protecting consumer rights and interests and preserving the market's innovative potential remains a complex task. On one hand, excessively strict regulation could "freeze" innovation and limit competition among new market entrants; on the other, underestimating the manipulative power of AI algorithms could lead to growing distrust in digital services and exacerbate social inequality. Consequently, many experts advocate for "soft" regulation, complemented by industry self-regulation, principles of privacy by design (embedding privacy and ethical principles into system architecture from the design stage), and voluntary participation in certification programs.

Thus, the ethics and legal regulation of artificial intelligence in the context of bounded rationality is a multifaceted issue requiring an interdisciplinary approach and coordinated actions from legislators, businesses, society, and end-users — who need comprehensive information about how algorithms operate and the risks they entail.

RECOMMENDATIONS FOR USERS AND BUSINESSES

Based on the analysis, several key directions can help maximize the benefits of AI while minimizing potential abuses:

1. *Improving digital literacy*. Users should understand how recommendation content is generated, the principles behind dynamic pricing, and the concept of choice architecture. Developing critical thinking skills, questioning advertising claims, and verifying information from multiple sources are essential for reducing vulnerability to manipulation.
2. *Self-regulation and business ethics*. Companies implementing AI should develop internal codes of ethics, provide employee training programs, and publish roadmaps for the use of algorithmic methods. This will increase transparency and foster trust in digital services.
3. *Balanced legal regulation*. Government authorities need to develop legislation that reflects the specifics of AI and the digital environment while avoiding overregulation that could stifle innovation. Finding a balance between protecting citizens' interests and promoting technological development is crucial.
4. *Institutions for external algorithm audits*. Independent expert groups or specialized agencies could evaluate algorithms for potential discrimination, dark patterns, or unfair dynamic pricing. Such practices, already discussed at the international level, would enhance corporate accountability and protect end-users.
5. *Building digital immunity*. Beyond formal legislation and business ethics, fostering a culture of responsible technology use is important. Skills in mindful consumption, avoiding impulsive purchase traps, and critically evaluating algorithmic

recommendations should be cultivated through educational initiatives by governments, universities, and digital platforms themselves.

CONCLUSION

In the context of the digital economy, bounded rationality — conceptualized by H. Simon and widely recognized in behavioral economics — takes on new forms. AI tools, on one hand, can simplify consumers' lives by offering personalized selections and instant calculations of optimal choices, and on the other hand, can be used to manipulate behavior and increase profits through decisions that are not always fully conscious or justified. As demonstrated by examples from e-commerce, online booking platforms, and robo-advisors, the effects of AI technologies are complex, generating both positive and negative outcomes.

As the role of AI in marketing and commercial processes grows, ethical and regulatory issues will become increasingly pressing. Attention is already rising around problems such as discrimination, dark patterns, and uninformed consent. Government authorities and expert communities will need to strike a balance between fostering innovation and ensuring consumer protection.

Practically, it is important to develop "digital immunity" among users — the ability to understand the logic of algorithmic systems and critically evaluate their recommendations. Businesses should exercise social responsibility by implementing voluntary codes of ethics and avoiding aggressive manipulative practices, while legislators should continue to seek optimal regulatory measures that protect consumers without stifling economic activity.

Thus, the synergy of bounded rationality and artificial intelligence is becoming a key driver of transformation in consumer behavior within the modern digital economy. How these technologies are implemented, and how consciously all market participants engage with them, will determine whether AI becomes a tool for enhancing efficiency and convenience or a mechanism for covertly imposing goods and services. Future research in this area must take into account the interdisciplinary nature of the issue, spanning economics, psychology, computer science, and law.

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Analysis of Foreign Experience in the Organization of State Financial Control

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ABSTRACT

Relevance. State financial control is a mechanism that enables to increase the efficiency of using budget funds. International practice shows that there are different approaches to organise the activities of state financial control bodies, due to a country's national characteristics, form of government, as well as the applicable legal system in a particular country. **The purpose** of this study is to analyse international experience in the organisation of state financial control, as well as identify potential areas of its application in the Russian Federation. **The objects** of the research have become national and supranational bodies of state financial control. **The subject** of the study is the activities of global state financial control authorities. **The methodological basis** of the research was a set of general scientific methods of cognition: analysis, synthesis, comparison and classification. **Results.** During the course of the study, the author identified general and specific characteristics of state financial control bodies in foreign countries, as well as the promising areas for the system of state and municipal financial control of the Russian Federation.

Keywords: state financial control; international experience; state audit; state financial control bodies

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INTRODUCTION

State financial control (SFC) is an integral part of the state's financial system. Its establishment in Russia dates back to the 17th century. Over time, the institutional environment has been changing, including aims, tasks, forms, and methods of SFC undergoing specification [1].

Despite the fact, that a substantial theoretical and applied foundation for implementing SFC exists in Russia, it is useful to examine a similar foreign experience related to its organisation. Such an examination should include the identification of features characteristic of states with different forms of government and legal systems, with consideration to assessing potentially their practical applicability into the Russian reality.

International Organisations of State Financial Control Bodies

Before assessing the organisation of SFC in foreign countries, it is appropriate to examine the types and objectives of international associations of control bodies.

The landscape of such associations includes global, European, African, Arab, Asian, Latin American, Pacific, and Caribbean enterprises of Supreme Audit Institutions (SAIs).[1]

Their primary objective is to promote the development of SFC related to audit by means of research and the exchange of expertise, the identification of the most effective approaches to its application, as well as the standardisation of audit procedures.

The fundamental documents are the Lima Declaration of Guidelines on Auditing[2] in addition to the subsequenty adopted Mexico Declaration on the Independence of Supreme Audit Institutions,[3] both developed by the International Organisation of SAIs.

These documents declare the principle of independence, both organisational and functional, as a key principle in the activities of supreme audit institutions.

Within the framework of the 23rd Congress of the International Organisation of SAIs, held in Moscow in September 2019, its participants adopted the Moscow Declaration.[4] This document reaffirmed the importance of the principle of independence for SAIs and emphasised the need to employ achievements of technological progress in exercising control over public administration.

Analysis of International Experience in Organising State Financial Control

The specific features of SFC organisation in foreign countries stem from various factors, including the established form of governance and the adopted legal system. This is evident, for instance, in the procedures for appointing leaders and members of SFC bodies by the president, Parliament, or monarch.

Researchers distinguish legal systems between republican (presidential, parliamentary), monarchical (absolute or constitutional), and mixed forms of state governance [2], as well as Romano-Germanic (continental) and Anglo-Saxon (common law) ones [3]. Countries with a republican form of governance include Russia, the United States, France, and China.[5] A monarchical form is distinctive for the United Kingdom, Japan, and Sweden [4]. A mixed form of governance currently exists in Finland [5], Kazakhstan, and Uzbekistan [6].

The legal systems of Russia, Germany, and France are considered as Romano-Germanic, while the legal systems of the United States, the United Kingdom, and a few other countries are Anglo-Saxon.

Let us analyse key aspects of SFC organisation in some foreign countries with different forms of governance and legal systems.

In Germany, the Federal Court of Audit, the State Courts of Audit, and the Federal Ministry of Finance exercise SFC functions.

[1] Official website of the International Association of Supreme Audit Institutions. URL: https://www.intosai.org/ru/o-nas/regionalnye-organizacii.html

[2] Official website of the Moscow Accounts Chamber. https://ksp.mos.ru/documents/deklaratsii/limskaya-deklaratsiya/

[3] Official website of the Federal Treasury. URL: https://roskazna.gov.ru/upload/iblock/b8b/issai-10.-meksikanskaya-deklaratsiya-nezavisimosti-vofk_rus.pdf

[4] Official website of Moscow's Chamber of Control and Accounts. URL: https://ksp.mos.ru/documents/deklaratsii/moskovskaya-deklaratsiya-incosai/

[5] URL: https://znanierussia.ru/articles/Республика

The General Accounting Office, which is an independent collegiate audit body in Germany, was founded in 1714.

In 1950, the currently operating Federal Court of Audit was instituted. It is an independent supreme audit body, which assists the Bundestag, the Bundesrat, and the Federal Government in formulating and adopting relevant decisions.[6]

Its main task envisages auditing federal budget revenues and expenditures.[7] Besides, it is responsible to control the activities of state-owned enterprises and organisations, which receive budgetary funds.[8]

The Federal Court of Audit is headed by the President and the Vice-President. They are elected by Bundestag and Bundesrat respectively, based on government proposals. The term of service at the Court's leadership is restricted to twelve years.

Its organisational framework includes Departments and Auditing Units. In addition to this, it also comprises a Principal Council, headed by the President, and Councils in each Department.

The President, Vice-President, and Heads of Departments and Units possess judicial independence, namely, regarding the performance of their official responsibilities and decision-making process, they are adhering solely to the law.[9]

The German Federal Court of Audit undertakes performance audits, within the framework of which it assesses the decisions scheduled for adoption that leads to budget expenditures. It also runs financial audits to evaluate the legality of transactions and approves the federal annual accounts.

In addition, it annually reports on its activities to the Bundestag, Bundesrat, and the Government.[10]

Germany embodies a decentralised model of SFC organisation, within the framework of which (besides the federal-level body exercising control at the state level) there operate local bodies (Regional Courts of Audit) [7] that control the income and expenditure of the corresponding region, and they report on the results to their local Parliament and Government.

The State Courts of Audit are independent of the Federal Court of Audit, although they may engage in joint activities.[11]

As in other countries, the German Federal Ministry of Finance ensures control over preparation of the budget. However, there exist some distinctive peculiarities. For instance, the Federal Ministry of Finance delegates representatives to each ministry, who supervise the legality and efficiency of financial operations carried out there [8]. The Budget Committee of the Bundestag also plays a considerable role in the sphere of SFC, reviewing the draft budget and monitoring its implementation.[12]

In **the United States**, the General Accounting Office was established in 1921 as the principal SFC institution to supervise increasing public expenditure and debt, with a special focus on assessing their legitimacy and expediency. Subsequently, the domain of tasks of the General Accounting Office expanded to include monitoring and evaluating government spending. In the year of 2004, it was renamed the Government Accountability Office (GAO), which was related to the further broadening of its mandate.[13]

Currently, the GAO assesses the efficiency of public spending and performance of programmes. It audits financial statements of federal agencies, focusing on forty agencies, which account for 99 per cent of the total amount of assets, liabilities, and expenses.[14]

Additionally, the GAO develops standards for internal control for federal ministries (departments

[6] "Law on the Federal Court of Auditors" — Official website of the Federal Court of Auditors of Germany URL: https://www.gesetze-im-internet.de/brhg_1985/index.html

[7] "The German Law on the Budget". Pashkov Library. URL: https://constitutions.ru/?p=24535

[8] Eurasian Legal Portal https://www.eurasialegal.info/index.php?option=com_content&view=article&id=1107:2012–04–09–03–20–27&catid=1: eurasianintegration&Itemid=42

[9] "Law on the Federal Court of Auditors" Official website of the Federal Court of Auditors of Germany. URL: https://www.gesetze-im-internet.de/brhg_1985/index.html

[10] "Eurasian legal portal". https://www.eurasialegal.info/index.php?option=com_content&view=article&id=1107:2012–04–09–03–20–27&catid=1: eurasianintegration&Itemid=42

[11] "The German Law on the Budget". Pashkov Library. URL: https://constitutions.ru/?p=24535

[12] Official website of Bundestag. URL: https://www.bundestag.de/en/committees/a08

[13] Official website of the Government Accountability Office. URL: https://www.gao.gov/about/what-gao-does/history

[14] Excerpt from the statement of the U.S. Comptroller General Eugene L. Dodaro to the Audit General Chamber of the Kingdom of Saudi Arabia, dated October 30, 2024. URL: https://www.gao.gov/about/comptroller-general/presentations/2024

and agencies) and it receives annual reports on their implementation. The GAO is presided by the Comptroller General, who is appointed by the US President upon the recommendation of the Senate for a term not exceeding 15 years.

Particular attention should be paid to the US audit standards, some of which include:

- general approaches to conducting audits, preparing audit reports, and
- requirements for auditors (the "Yellow Book");
- internal control guidelines (the "Green Book");
- principles of federal budget appropriation law (the "Red Book"), which also
- include the rights of the Comptroller General to define and issue rulings and opinions on the use of public funds.[15]

The US Congress exercises three main stages of control in the process of review and approval of the federal budget:

1. The relevant Authorising Committee approves a programme which requires budget funding.
2. The Appropriations Committee authorises the funding of the programme and determines its cost.
3. Following the adoption of the budget law, the funding is allocated for the programme [9].

Some scholars identify the US President's Office of Management and Budget (OMB), the largest unit of the US administration, as a US SFC body [8]. However, from our perspective, in view of the OMB's core tasks related to formulating the US draft budget and managing the unified treasury account [10], it is appears more appropriately to be classified as a financial body.

Each US state forms its own SFC. For example, New York State has established a Department of Audit and Control, headed by Comptroller officially elected by the legislature.[16]

On October 1, 1978,[17] the "Inspector General Act" came into effect in the USA. The US President, with the recomendation and aproval of the Senate, appoints the Inspectors General to respective agencies for internal control purposes, aimed at preventing illegal and inefficient actions. The Inspector General coordinates the agency's activities with the Comptroller General and, upon identifying fraudulents under criminal law, he immediately notifies the latter about it.

Furthermore, twice a year the Inspector General presents a report to the US Congress submitting information on identified problems and violations, along with recommendations for their resolution.

The US Department of Treasury can also be classified a US SFC body. It is responsible for tax collection and budget expenditure execution, as well as produces estimates of government revenues and expenditures, supervises revenue collection and banking activities, and controls the use of budgetary funds.[18]

In France, the history of the national SFC body dates back to the first half of the 19th century [11]. France, like Germany and the United States, establishes a decentralised model, where regional and local Courts of Accounts are independent bodies. Never the less, the French Court of Accounts, as the supreme SFC body, exercises an inspection function in relation to the regional and local Courts of Accounts.[19] The Court's competence includes auditing state revenues and expenditures, state-owned enterprises, social security institutions, etc. Its mandate involves auditing completed financial operations, as control over current operations falls within the competence of the Ministry of Finance. In addition, it applies only to verification of completed financial operations, since ongoing oversight falls within the powers of the Ministry of Finance [8].

In conformity with the French Constitution, the supreme SFC body of the country assists the Parliament in monitoring government performance, as well as it supports the Parliament and the Government in executing finance laws, social security laws, and in evaluating public authorities.[20]

[15] Official website of the Government Accountability Office. URL: https://www.gao.gov/about/comptroller-general

[16] URL: https://en.wikipedia.org/wiki/New_York_State_Comptroller

[17] "Inspector General Act". URL: https://www.govtrack.us/congress/bills/95/hr8588/text.

[18] Official website of the U.S. Department of the Treasury. URL: https://home.treasury.gov/history/act-of-congress-establishing-the-treasury-department#reg

[19] Code of Financial Jurisdictions. URL: https://www.legifrance.gouv.fr/codes/section_lc/LEGITEXT000006070249/LEGISCTA000006085909/#LEGISCTA000006085909

[20] Constitution of the Republic of France. URL: https://constitutions.ru/?p=285

The Cabinet of Ministers appoints the President of the Court of Accounts by a special decree. The President also heads the Court of Audit Appeals, which reviews appeals related to decisions previously made by the Court[21] and selects auditors, whose terms of office are limited to three years. Meanwhile, the French President appoints half of the Court's members, who hold magistrate (judge) status, for life tenure [11].

The Court's collegial body, the High Council, examines the results of auditing activities, drafts of annual reports etc. at its sessions.

Distinctive features of SFC organisation in France include the authority of the Court of Accounts to delegate its powers related to specific audit entities to regional or local Courts of Accounts of French Polynesia, New Caledonia, Saint-Barthélemy, Saint Martin, and Saint-Pierre and Miquelon.[22]

Another notable specific feature of the French Court of Accounts is the organisational structure, which includes the Public Prosecutor's Office in charge of providing consultations on legislative issues and reviewing audit reports [8].

Its representatives are also present to participate in the regional and local Courts of Accounts. Each year, the Court of Accounts submits a report covering its activities to the President, the Government, and the Parliament. Among the French Government SFC bodies, there should be noted the General Inspectorate of Finance as well. It is subordinate to the Ministry of Economy and Finance and in charge of supervising the activities of enterprises, which have access to budgetary funding [8, 12].

In the **United Kingdom**, the SFC institution is the National Audit Office (NAO). It inspects the expenditures of government departments and a significant public sector of enterprises in the United Kingdom (for instance, such as the BBC and Network Rail). It also evaluates the efficiency of budget expenditures, develops recommendations for improving their economic effectiveness, audits local authorities, and validates the credibility of government accounts.[23] Such SFC body was constituted back in 1861, when the UK House of Commons created the Committee of Public Accounts, and five years later, the position of Comptroller and Auditor General was introduced [11]. Nowadays, the NAO is presided by the Comptroller and Auditor General, who is appointed for a 10-year term by the Monarch upon a recommendation of the House of Commons. The Comptroller and Auditor General is a full-fledged member of the House of Commons. It is necessary to mention, that Wales, Scotland, and Northern Ireland have their own SFC institutions. For example, there operates the Northern Ireland Audit Office.[24] The NAO submits reports to the UK Parliament on its performance, reports on verification of its own activity etc. In the framework of implementation of financial and performance audits, the NAO renders a special emphasis on the following aspects:

- verification of the reliability of budgetary reporting;
- assessment of effective and efficient performance, as well as economy of resources used by government institutions;
- developing recommendations to improve public services.[25]

The NAO develops the Code of Audit Practice as well, which defines requirements for local institutions to perform their functions. The current version of the Code in force, dated November 14, 2024, provides general recommendations on conducting audits, including audit planning and reporting.[26] His Majesty's Treasury combines functions for developing and administering state policy in finance and economics by means of budget preparation and implementing, as well as controlling budget expenditures, including through the Government Internal Audit Agency (GIAA).[27]

[21] Code of Financial Jurisdictions. URL: https://www.legifrance.gouv.fr/codes/section_lc/LEGITEXT000006070249/LEGISCTA000006085909/#LEGISCTA000006085909

[22] Code of Financial Jurisdictions. URL: https://www.legifrance.gouv.fr/codes/section_lc/LEGITEXT000006070249/LEGISCTA000006085909/#LEGISCTA000006085909

[23] Official website of the NAO. URL: https://www.nao.org.uk/about-us/

[24] Official website of the Northern Ireland Audit Office. URL: https://www.niauditoffice.gov.uk/

[25] Official website of the UK Parliament. URL: https://committees.parliament.uk/committee/207/public-accounts-commission/role/

[26] Official website of the NAO. URL: https://www.nao.org.uk/wp-content/uploads/2024/11/code-of-audit-practice-2024.pdf

[27] Official website of His Majesty Treasury. URL: https://www.gov.uk/government/organisations/hm-treasury

The GIAA operates as an executive agency of His Majesty's Treasury, founded in order to improve the quality of internal audit in the central government.[28]

The NAO and His Majesty's Treasury develop guidelines documents to improve conducting SFC (audit) and internal audit. Among these documents, we should note the abovementioned Code of Audit Practice, as well as the Internal Audit Standards for Public Sector and the Handbook for Internal Audit and Risk Assurance Committees.[29]

The UK Parliament also oversees government spending. It is worth mentioning that the Committee of Public Accounts of the House of Commons bears responsibility for this and a member of the opposition party is traditionally entrusted to chair the supervising function.[30]

It is worth noting, that, besides the decentralised systems, some European countries, such as **Austria and Sweden**, have established a centralised model of SFC [12].

It is of certain interest to consider the experience of establishing SFC in some **Asian countries**, represented by various forms of governance: a parliamentary republic in The People's Republic of China, or India, a presidential republic in The Republic of Korea, or a constitutional monarchy in Japan.

China has established a vertical structure for controlling public finances. The financial control body is the National Audit Office of the People's Republic of China (CNAO). Auditor-General heads CNAO appointed by the Premier of the State Council of China [13].

Municipal Audit Offices operate at the local level, submitting reports both to the CNAO and to local government institutions. The system works likewise, for example, with the Audit Office of Province of Hubei and its city-level representative Offices.[31]

The CNAO's audit authority extends to all the state entities and enterprises. Among other SFC institutions in China, there are the State-owned Assets Supervision and Administration Commission (SASAC)[32] of the State Council, established in 2003 to coordinate the activities of various agencies in managing state-owned enterprises [14].

Currently, SASAC conducts internal audits of property of state-owned enterprises, prepares draft laws on state-owned property management, and oversees internal control and audit systems, risk management, as well as handles other functions.[33]

The Ministry of Finance supervises budgetary expenditures of the central government of China, monitors treasury operations and the social security fund[34] as well.

In compliance with the Constitution of **India**, the President nominates the Comptroller and Auditor General (CAG). The latter is not allowed to hold office in the central or state governments after retirement.[35] The CAG is appointed for the term of 6 years and cannot hold this position upon coming of age over 65 years.[36] The Indian CAG's Department, also called the Indian Audit and Accounts Department, was created in 1860. Currently, it is in charge of conducting audits of the accounts of all government institutions (federal, regional, and local). It also conducts audits of budget revenues and expenditures, public corporations and companies, and commercial enterprises controlled by the Indian Government or state Governments. It conducts inspection of certain local authorities and institutions[37] and exercises its powers by means of compliance or performance audits, as well as through financial audits.

[28] Official website of UK State Services. URL: https://www.gov.uk/government/organisations/government-internal-audit-agency/about

[29] Official website of the UK Government Sources. URL: https://www.gov.uk/government/publications/audit-committee-handbook

[30] Official website of the Parliament of the Great Britain. URL: https://committees.parliament.uk/committee/127/public-accounts-committee/

[31] Official website of the Municipal Audit Office of the Province of Hubei. URL: https://sjt.hubei.gov.cn/sjzx/

[32] Official website of the State-owned Assets Supervision and Administration Commission. URL: http://en.sasac.gov.cn/index.html

[33] Official website of the State-owned Assets Supervision and Administration Commission. URL: http://en.sasac.gov.cn/2018/07/17/c_9258.htm

[34] Official website of the Ministry of Finance of the People's Republic of China. URL: https://www.mof.gov.cn/en/abus/mf/

[35] The Constitution of India. URL: https://legalns.com/download/books/cons/india.pdf

[36] "The Comptroller and Auditor General of India (Duties, Powers and Conditions of Service) Act, 1971". URL: https://www.nextias.com/blog/comptroller-and-auditor-general-of-india/

[37] The official website of The Comptroller and Auditor General of India. URL: https://cag.gov.in/en/faqs

A compliance audit is conducted to determine whether financial operations meet the requirements in accordance with the laws, contracts, and agreements. It also provides the assessment of performance of government officials. A financial audit is aimed to specify whether reporting complies with accounting standards and legal regulations. A performance audit allows comprehending whether implemented programmes and measures align with principles of cost-effectiveness and efficiency. Furthermore, it provides recommendations for improving resource management.[38]

Information on audit results is channeled to the President and all state governors of India, meanwhile in their turn they submit the results to the Parliament and their state legislatures, respectively.

In **Japan**, the Board of Audit is an independent constitutional SFC institution [13]. Initially, it was founded in 1869 as a Division of the Ministry of Finance, and later, in 1947, it achieved its independent status.[39]

The Board's essential objective is ensuring sustainable financial management. Consequently, it is empowered to audit income and expenditure accounts at the national scale, recipients of budget subsidies, enterprises, whose authorised capital is partially backed up from the state, among other sources, by means of budget funding, as well as tax inspectors, and local entities [13].

The Board comprises the Commission of Audit and the General Executive Bureau. The Commission of Audit consists of three members: Chairman and two Commissioners, authorised officials, all of them are appointed by the Cabinet with the consent of both Houses of the Diet for the term of 5 years and formally appointed by the Emperor.[40] The term of service of the Chairman may be extended once.[41]

The General Executive Bureau undertakes an audit by its Secretary-General, who is supervised by the Commission members. The auditing standards define its key objectives:

- Accuracy (objectivity of the information in reports).
- Economy (achievement of the targeted objectives with minimal cost).
- Correctness (in compliance with legal requirements in managing public finances).[42]

Besides, the issues of verification of the internal control system are taken into account separately in the standards.

Reports on audit results are submitted to the Diet and the Cabinet of Ministers.

The Republic of Korea represents another example of a centralised SFC model: the Board of Audit and Inspection (BAI) was established under the President in 1948 aimed to conduct inspection of the central Government, local authorities, state-run entities and other enterprises defined by law.[43]

Currently, the Board of Audit and Inspection operate with the status of supreme SFC body in the Republic of Korea. BAI is headed by a Chairman appointed for a 4-year term by the President of the nation upon the recommendation of the National Assembly.[44] The President of the Republic of Korea also appoints BAI Commissioners for the same 4-year term based on the similar recommendation of the Chairman (the procedure is comparable to the appointment of auditors of Accounts Chamber of the Russian Federation).

BAI's collegiate body (Council) is established within the structure focused to take decisions related to organisational agenda, consider audit results, etc.

The BAI controls the revenues and expenditures of the state and local budgets, implementing performance audits, as well as financial, managerial,

[38] The official website of The Comptroller and Auditor General of India. URL: https://cag.gov.in/en/faqs

[39] Official website of The Commission of Audit of Japan URL: https://www.jbaudit.go.jp/english/jbaudit/history.html

[40] Official website of The Commission of Audit of Japan URL: https://www.jbaudit.go.jp/english/jbaudit/commission.html

[41] The Law on The Commission of Audit of Japan. URL: https://www.jbaudit.go.jp/english/jbaudit/law.html

[42] URL: https://www.jbaudit.go.jp/english/effort/pdf/auditingstandards_r040908.pdf

[43] Official website of the Board of Audit and Inspection. URL: https://www.bai.go.kr/bai_eng/intro/briefHistory

[44] The Law on the Establishment of the Board of Audit and Inspection. URL: https://www.law.go.kr/LSW/eng/engLsSc do?menuId=2&section=l awNm&query=Board+of+Audit+and+Inspection+Act&x=34&y=22#liBgcolor0

and initiative audits.[45] However, it conducts the latter upon receipt of requirements in a petition signed by no less than 300 individuals.

Furthermore, the BAI develops audit standards and codes of audit practice and subsequently reports on this activity to the President of the nation.

The Republic of Korea attaches significant importance to internal audit: it has established Audit Units in central and local agencies and they act in accordance with statutory requirements.[46] The law stipulates the procedure for forming Internal Audit Units, appointing their directors and interacting with the BAI as well. It also allows any enterprise to be exempt from BAI inspection in case if the level of activity of its Internal Audit Unit is considered of high-quality.

To conclude the review of the SFC organizations in foreign countries, we analyse how they operate **at the supranational level**.

Within the process of European integration, the agenda of insurance of independent control over the European Commission's activities in executing the European Union budget has been given an essential importance [15].

One year after the signing of the Treaty of Rome (1957) which resulted to establishing the European Economic Community,[47] a miniature Audit Board was set up. As the Community's budget increased, the European Parliament acquired its control, and in 1975, the European Court of Auditors (ECA) was established.[48]

The Maastricht Treaty, which entered into force on November 1, 1993, upgraded the social status of the Court of Auditors to an EU institution (on equal terms with the European Parliament and the European Council).[49]

In accordance with the Treaty on the Functioning of the European Union,[50] the ECA includes one representative from each EU member state, appointed for a 6-year term by the European Council after the approval of the European Parliament. Meanwhile the term of service for President of the Court of Auditors is 3 years.

Ensuring independence of all members of this control organisation is of essential importance. For instance, the ECA representatives are strictly forbidden to take instructions from any government or other enterprises of the EU member states.

The structure of the ECA includes the following: Audit Chambers, Audit Quality Control Committee, Administrative Committee, and Secretariat General.

The ECA monitors to control the income and expenses of the European budget and it assesses the effectiveness of financial management of the Union.

The existence of a single control body does not necessarily exclude the participation of national Supreme Audit Institutions of the ECA in audit activity, however, only if they operate as observers.

Reports on the results of audit measures are channeled to the European Parliament, the Council of Economic and Financial Affairs, as well as to the Parliaments of all member states.[51]

CONCLUSIONS

The study of experience in establishing SFC bodies indicates that these bodies play one of the leading role in the process of state financial management.

Their main focus includes budget expenditures, assessing their effectiveness and legality, and confirming the reliability of reporting.

Consequently, international Supreme Audit Institutions, which unite SFC bodies from various countries, operate in accordance with the existing largely homogeneous principles for their activities and common tasks.

However, they have some specific peculiarities. For example, the French Court of Accounts

[45] Official website of the Board of Audit and Inspection. URL: https://www.bai.go.kr/bai_eng/intro/briefHistory

[46] The Law on the Control in the Governmental Sector. URL: https://www.law.go.kr/LSW/eng/engLsSc.do?menuId=2&query=ACT%20ON%20PUBLIC%20SECTOR%20AUDITS#liBgcolor0

[47] Official website of the European Parliament. URL: https://www.europarl.europa.eu/about-parliament/en/in-the-past/the-parliament-and-the-treaties/treaty-of-rome

[48] Official website of the European Union. URL: https://www.eca.europa.eu/en/history

[49] The Treaty on European Union. (Maastricht, February 7,1992). URL: http://oceanlaw.ru/wp-content/uploads/2018/02/Договор-о-Европейском-Союзе.pdf

[50] Official website of the European Union. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12016ME%2FTXT

[51] URL: https://op.europa.eu/webpub/eca/book-state-audit/en/

incorporates the Public Prosecutor's Office in it organisational structure. It is also essential to identify two major models of SFC organisation: decentralised (in Germany, or USA) and centralised (in The People's Republic of China, or in the Republic of Korea).

According to the author's viewpoint, the US experience related to the institution of Inspectors General deserves comprehension. It could be introduced in domestic practice and this seems highly pertinent, since Russia currently lacks a unified system of internal financial control and audit [16].

It is worth evaluating an interesting practice of several countries in creating a unified SFC body that controls budgets at all levels. In our viewpoint, this approach could be useful for establishing internal SFC currently performed by the Federal Treasury, as well as the bodies of the constituent entities and municipalities of the Russian Federation [17].

The experience of the Republic of Korea is equally interesting regarding the cases of exempting enterprises from inspections, if the activity of their Internal Audit Units is estimated of high enough. Applying this approach in Russia could mitigate the burden on SFC bodies and boost the efficiency of public financial allocations [16].

The inspection function of the French Court of Accounts, applied towards regional and local Courts of Accounts, also seems quite pertinent and promising for our country.

Furthermore, as the Union State of Russia and Belarus are in constant development and, consequently, the amount of its joint budget grows, the European practice of creating a supranational SFC body will be required.

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Asset Management Models of Institutional Investors Under High Volatility in 2022–2024

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ABSTRACT

Subject. This article examines portfolio-based asset management models employed by institutional investors amid the high volatility observed in financial markets during the period from 2022 to 2024. Macroeconomic instability, surging inflation, escalating geopolitical risks, and rising interest rates imposed by central banks across the globe contributed to portfolio shifts toward bonds, safe-haven assets (such as gold and commodities), and hedging instruments. **Objective.** The paper aims to identify the factors that prompted the reassessment of investment strategies by major hedge funds, investment banks, as well as pension, sovereign, and endowment funds. **Findings.** The authors present a typology of modern investment strategies and analyze how institutional investors applied various approaches to liquidity management and portfolio exposure control during periods of sharp price fluctuations. Through case studies of leading hedge funds and investment banks, the paper demonstrates that combining quantitative strategies and algorithmic models with fundamental analysis enables investors to achieve high returns while effectively managing risk. **Scientific significance.** The findings offer valuable insights for institutional investors building portfolios in conditions of elevated market uncertainty.

Keywords: investment portfolio; asset management; investments; institutional investors; investment strategies

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INTRODUCTION

The geopolitical and macroeconomic developments of recent years have significantly influenced investor behavior in financial markets, compelling them to reconsider both short-term and long-term strategies. The traditional long-horizon investment approach, widely used until recently, has become less attractive in terms of the risk-return trade-off, prompting adjustments in the portfolio structures of many major global institutional investors. Globalization and digitalization have transformed financial markets, making them more open but simultaneously more exposed to various types of risks. Investors and regulators now need to consider a broader set of factors when managing capital and assessing potential threats.

The onset of a period of high volatility was marked by substantial fluctuations in equity markets: in 2022, the broad U.S. market index S&P 500 declined by 19.4% [1], representing the fourth-worst performance since its inception and the deepest drop since the 2008 financial crisis. During the same period, the Moscow Exchange Index fell by 43.1% [2]. Stock market volatility and high uncertainty in expectations triggered widespread inflationary pressures, which, in turn, led central banks to implement measures to curb inflation through interest rate hikes.

Between 2022 and 2024, many large pension funds, hedge funds, investment banks, and sovereign wealth funds actively adapted their portfolios to these changing market conditions. They began reallocating assets toward safer and more profitable instruments, such as government and corporate bonds, particularly amid rapidly rising borrowing costs. The portfolio structures of most major institutional investors were revised to capitalize on opportunities to stabilize interest income and to protect capital from market fluctuations [3].

Interest rate hikes by central banks in response to inflation contributed to higher yields in money and credit markets. Consequently, portfolio structures were adjusted, for example, by increasing the share of fixed-income bonds. Changes in interest rates also affected approaches to liquidity management. Active cash management and the reallocation of capital into more liquid short-term assets allowed investors to respond flexibly to market changes, enabling timely portfolio restructuring and enhancing returns.

Economic instability, high inflation, geopolitical risks, and volatility in energy markets further increased interest in protective assets such as gold, precious metals, and commodities, which traditionally serve as safe havens during periods of high volatility. For instance, sovereign wealth funds (Norway's Government Pension Fund and China's CIC) and hedge funds (Bridgewater Associates) increased the share of gold in their portfolios[1] to 10%. Exchange rate volatility also prompted greater use of risk-hedging instruments, such as forward contracts and options, providing additional protection for portfolio returns against sharp currency fluctuations, particularly amid widening interest rate differentials between major economies.

Volatility in traditional markets has stimulated the search for new sources of return. Institutional investors have increasingly allocated funds to alternative assets, such as private equity and venture capital, while actively investing in cryptocurrencies and real estate. This strategy has helped reduce their dependence on equity markets.

Overall, 2022–2024 has been a period of active adaptation and transformation in portfolio management strategies, driven by financial market volatility, rising inflation, changing interest rates, and increasing geopolitical risks.

CHANGES IN INVESTMENT STRATEGIES

Modern financial markets have become more efficient and accessible, yet they are simultaneously characterized by heightened sensitivity to crises, volatility, and exposure to various risks.

[1] China Investment Corporation. Annual Report 2022. URL: https://www.carobnistapic.com/chinainven/xhtml/Media/2022EN.pdf; Government Pension Fund Global. Annual Report 2023. URL: https://www.nbim.no/contentassets/75e18afc40974cb189e3747164def669/gpfg-annual-report_2023.pdf; Bridgewater Annual Report and Accounts 2022–23. URL: https://bridgewater.nhs.uk/wp-content/uploads/2023/08/Bridgewater-Annual-Report-and-Accounts-2022–23.pdf

Among these are variability and uncertainty, which reflect deviations of actual returns from expected returns — typically in a direction unfavorable to an investor's market position. Reducing risk under these conditions requires adjustments to investment approaches, which has been reflected in the revision of strategies by the majority of market participants.

Quantifying risk amid the constant emergence of unpredictable events, often referredto as "black swans,[2]" has become increasingly difficult. A mathematical interpretation of current financial market conditions, based on stock indices, reveals that the distribution of five-year historical returns exhibits "heavy tails," indicating a higher probability of extreme events. In addition, the dynamics show sharp outliers — both positive and negative — which are critical to consider when developing modern investment strategies [4].

In the presence of "heavy-tailed" distributions, investment strategies must account for the heightened risk of sudden price swings and incorporate a wide range of risk management methods (see *Table 1*).

The use of a broad array of methods in modern investment strategies allows large institutional investors to maintain a balance between high returns — often outperforming market averages — and capital protection under conditions of elevated kurtosis.[3] The foundations for optimizing the risk-return trade-off of investments are defined by portfolio theory [5], which primarily emphasizes broad diversification of assets, both across different *types* (stocks, bonds, gold, real estate, etc.) and *geographically*. Diversification reduces the risk of significant losses, for example, from sharp price movements in a single market or the impact of localized risks on the value of regional assets. Protection against adverse market fluctuations can also be achieved through hedging mechanisms, though this may potentially limit returns or reduce profits (for example, due to premiums paid for options). Historically, these measures have demonstrated high effectiveness and are widely applied in investment capital management.

[2] A "black swan" is a rare and unexpected event whose consequences are significant for the global economy, financial markets, and other socioeconomic systems. A "black swan" cannot be predicted in advance based on available information.

[3] Kurtosis or excess kurtosis measures the shape of a distribution with sensitivity to the "tails of the distribution" an indicator of the frequency or probability of extreme events.

Table 1

Risk Management Methods in Investment

Method	Implementation Opportunities
Portfolio Diversification	• Diversification across asset types • Geographic diversification
Risk Hedging	• Derivative financial instruments • Swaps • Currency hedging
Controlled Exposure and Dynamic Asset Reallocation	• Use of specialized strategies for high-volatility markets • Asset reallocation • Asset rotation • Risk-parity tactics
Liquidity Management	Reallocation of asset shares based on liquidity: • Highly liquid assets: short-term government bonds (US Treasuries, T-bills), ETFs on major indices (S&P 500, Nasdaq, MSCI World), cash and money market funds (MMFs) • Less liquid assets: low-rated corporate bonds, private equity, venture investments, real estate, infrastructure funds
Monitoring Risk Position	• Value at Risk (VaR) and Conditional VaR (CVaR) • Evaluation of the tails of return distributions • Stress testing

Source: compiled by the authors.

However, in an environment of increasing uncertainty and high market volatility, economic agents have had to refine their portfolio management approaches and exercise strict control over exposure. For instance, when significant market movements are anticipated, strategies that benefit from heightened volatility — such as option "straddles" or "strangles"— can be employed. These strategies allow investors to profit from substantial price movements of the underlying asset, regardless of direction, whether upward or downward.

The mechanism of controlled exposure helps manage portfolio risk flexibly and does not necessarily rely on betting on increased volatility. In general, exposure refers to the degree of capital allocated to a risky asset. When markets become more volatile, an investor may reduce exposure to limit losses — for example, by reallocating funds (reducing the share of equities and increasing investments in bonds or cash equivalents), preemptively setting stop-loss[4] orders to close positions at predetermined loss levels, or adjusting leverage to decrease or increase overall market exposure. In this way, portfolio volatility is reduced by decreasing the proportion of high-risk assets and increasing the share of protective assets.

In recent years, large funds and institutional investors, such as Bridgewater Associates, have also applied the risk-parity (or asset-switching) approach, which aims to achieve an optimal balance between risk and return [6]. This method involves adjusting the allocation of assets according to market conditions, helping to mitigate the impact of extreme events. **Tactical management** entails short-term portfolio adjustments based on current market conditions (for example, increasing equity exposure in a "bull market" or shifting to bonds in a "bear market"); **cyclical management** involves medium- to long-term adjustments to maintain balanced risk across assets in response to emerging trends; and **strategic management** is based on stress-test results or macroeconomic forecasts to change asset shares accordingly.

The risk-parity method is designed to maximize returns at a given level of risk through flexible adaptation to changing market conditions.

In 2022–2024, enhancing asset liquidity became a key factor in maintaining portfolio returns, particularly for investment funds, corporate treasuries, and private investors [7]. The sharp and widespread rise in interest rates in 2022–2023 (for instance, the Fed rate increase from 0.25% in March 2022 to 5.50% in early 2023) triggered a flight to money market funds and T-bills,[5] while long-term bonds lost 30–40% of their value.[6] Investors began reallocating capital to short-term instruments such as 3–12 month US Treasuries with yields of 4–5% and money market funds[7] (MMFs). The local banking crisis in the U.S. in 2023 further highlighted the high risk of illiquid assets amid deposit outflows, reinforcing the shift toward government bonds and gold.

Clearly, in an environment of high volatility and uncertainty, continuous monitoring of risk and kurtosis metrics to assess the probability of extreme events enables investors to respond swiftly to changing conditions. Regular stress testing and evaluation of portfolio resilience help adjust asset allocation in a timely manner, ensuring adequate returns while managing risk exposure.

INSTITUTIONAL INVESTOR STRATEGIES IN 2022–2024

Institutional investor strategies in 2022–2024 evolved in response to changing financial market conditions. A typology of these strategies highlights two key approaches to investment

[4] A stop-loss order is an order that automatically closes a position if the asset price reaches a predetermined loss level. Its purpose is to limit potential losses and protect the investor from large losses in the event of adverse market movements.

[5] Treasury bills (T-bills) are short-term government bonds issued by the U.S. Treasury. They are considered the safest assets in the world, as they are guaranteed by the country's government.

[6] URL: https://www.atlantis-press.com/proceedings/icemci-23/125997990

[7] Money Market Funds (MMFs) are money market investment funds that invest in short-term, highly liquid, and low-risk instruments such as T-bills (US government bonds), commercial paper (CP), repos, and deposits.

management: *developing a bespoke strategy* and *following the lead of major market players* [8]. Effective development of the first approach requires comprehensive market analysis, risk and opportunity assessment, continuous monitoring of market conditions, periodic portfolio review and rebalancing, and alignment with corporate goals and constraints — tasks that are typically feasible only for large institutional investors.

The second approach, which involves lower costs, entails executing trades based on pre-defined portfolio parameters aligned with a benchmark investor. Success in this case depends on the benchmark strategy's historical performance, the follower's accuracy in replicating it, and the ability to translate the investment recommendation into trades closely mirroring the "original" strategy. Small and medium-sized institutional investors often adopt this follower approach, lacking the resources for independent optimization, and are therefore willing to accept a temporary discount in returns due to execution lags.

Even when employing a copy-based approach, followers conduct careful historical analysis and use technical indicators to identify current market trends [9]. In fact, trend acceleration or deceleration often correlates with the entry or exit of mass investors into or from a strategy, making timely decision-making crucial for successful execution [10]. Followers open and close positions in line with prevailing trends, using stop-losses and other risk-management tools, while automated systems and algorithms enable rapid data analysis and trade execution.

Large institutional investors, with substantial capital at their disposal, develop personalized corporate investment strategies and, in some cases, even act as market makers[8] (*Table 2*).

As shown in *Table 2*, pension funds manage enormous volumes of long-term capital to ensure pensions and social payments. Their investment strategies are primarily based on diversification, with a focus on stable long-term returns and a commitment to traditional financial instruments (*Fig. 1*). It is worth noting that over the past five years, the share of alternative investments and private equity in their portfolios has increased. For example, the largest non-federal pension fund in the U.S., the California Public Employees' Retirement System (CalPERS), announced in 2024 an increase in its allocation to alternative assets from 33% to 40%.[9] Additionally, in 2022–2024, approaches to ESG[10]-focused investments and global markets (private equity and real estate) were revised, resulting in a reduced proportional share of these assets in the overall portfolio [11].

Unlike pension funds, which adopt conservative investment approaches, hedge funds employ active management strategies, including short selling with leverage, derivatives trading, and other mechanisms to achieve above-market returns. Consequently, their portfolios contain proportionally fewer traditional financial instruments (Table 3). For example, Bridgewater Associates focuses on macroeconomic trends, applies a risk-parity strategy, and constructs a portfolio of equities, bonds, commodities, and currencies, while using futures, options, and swaps to manage risk for individual positions. Daily portfolio rebalancing is performed through algorithmic models, but key decisions regarding the target structure are made by senior management. Renaissance Technologies employs a quantitative ("quant") approach, relying entirely on algorithmic management based on big data analysis and machine learning. Its investment strategy, developed with the help of artificial intelligence, focuses on identifying statistical anomalies and organizing arbitrage [12]. For 2022–2024, Renaissance Technologies' flagship fund, Medallion, achieved an average annual return of approximately 40% after all fees. Citadel LLC combines fundamental analysis, algorithmic trading, and arbitrage; its sub-fund, Citadel Securities, is one of the largest market makers in the U.S. equity

[8] Market makers are companies that, through their actions when buying and selling financial instruments, can shape current prices and trends in financial markets.

[9] URL: https://www.calpers.ca.gov/newsroom/calpers-news/2024/calpers-will-increase-private-markets-investments.

[10] An approach that takes into account environmental, social and corporate governance aspects in the decision-making process.

Table 2

Top-3 Institutional Investors by Asset Size in Various Categories, 2024

Category	Name	Country	Assets (USD)
Pension Funds	**Government Pension Investment Fund (GPIF)**	Japan	1.7 trillion
	National Pension Service (NPS)	South Korea	800 billion
	California Public Employees' Retirement System (CalPERS)	USA	500 billion
Hedge Funds	**Bridgewater Associates**	USA	160 billion
	Renaissance Technologies	USA	65 billion
	Citadel LLC	USA	60 billion
Investment Banks*	**J.P. Morgan Chase**	USA	3.7 trillion
	Goldman Sachs	USA	2 trillion
	Morgan Stanley	USA	1.3 trillion
Sovereign Wealth Funds	Norwegian Government Pension Fund Global	Norway	1.6 trillion
	China Investment Corporation	China	1.4 trillion
	Abu Dhabi Investment Authority	UAE	900 billion
Endowments	**Stanford University endowment**	USA	63 billion
	Harvard University endowment	USA	53 billion
	Yale University endowment	USA	42 billion

Source: complied by the authors.
Note: * consolidated financial statements were used, including assets under management and investment banking operations; the table reflects data as of the end of 2024, which may vary slightly depending on the source: however, the listed organizations consistently hold leading positions in their respective categories.

market, executing trades in corporate bonds and derivatives at very high speeds. Notably, each of these top three hedge funds has achieved success through a unique combination of technology, management models, and investment strategies.

One of the largest blocks of institutional investors in terms of assets under management is investment banks, which provide a wide range of client services, including asset management, investment advisory, underwriting, and more. The consolidated assets of J. P. Morgan Chase are estimated at USD 3.7 trillion, roughly 13% of the U.S. GDP. Such a scale undoubtedly determines the Group's ability to influence finan-

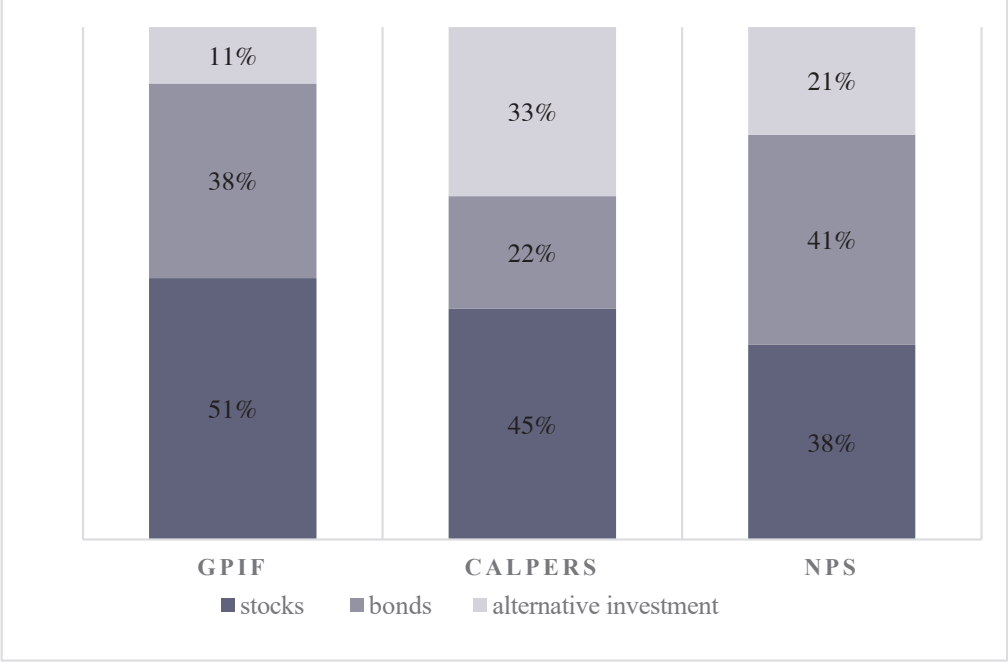

Fig. 1. **Portfolio Structure of Pension Funds [Government Pension Investment Fund (GPIF), National Pension Service (NPS), California Public Employees' Retirement System (CalPERS)] by Asset Classes as of Mid-2024**

Source: complied by the authors.

cial markets. J.P. Morgan Chase's investment strategy focuses on long-term investments with support for sustainable development initiatives (ESG and Impact Investing) and the formation of global equity and bond portfolios, including private equity and debt in emerging markets [13]. Goldman Sachs, whose assets amounted to USD 2 trillion by mid-2024, employs a multi-strategy approach that includes trading indices, equities, bonds, derivatives, investing in private equity, and infrastructure projects, with broad diversification across sectors and regions. Over the past five years, the bank has actively invested in fintech and cybersecurity startups. Morgan Stanley prefers equities, bonds, ETFs, and mutual funds, with a proportionally smaller share of alternative assets compared to traditional instruments.

Comparing the portfolio structures of these major investment banks, it is evident that Morgan Stanley has the highest percentage of equities, J.P. Morgan emphasizes bonds and credit strategies, and Goldman Sachs invests most aggressively in alternative assets, including private equity and hedge funds [13] (*Fig. 2*).

Sovereign wealth fund investments are aimed at preserving and growing the wealth of the country whose assets they manage. Their strategies focus on minimizing risks and ensuring steady asset growth, even during periods of crisis (*Table 4*). Sovereign wealth funds typically operate independently of the government but in the interests of the state and society, adhering to ethical, environmental, and social principles while setting investment priorities (for example, the real economy, infrastructure, and other sectors) [14].

The assets of the first three sovereign funds in *Table 4* are equivalent to approximately 2% of global GDP calculated by purchasing power parity. The assets of the Norwegian Government Pension Fund Global (GPFG) amount to USD 1.3 trillion, the China Investment Corporation (CIC) to USD 1.0 trillion, and the Abu Dhabi Investment Authority (ADIA) to around USD 700 billion. Sovereign funds play a key role in the global economy, influencing stock markets, commodities,

and technology sectors. Their asset management approaches typically include:

- *conservative style* with a high proportion of bonds in the portfolio (e.g., Singapore);
- *aggressive style* with a high share of equities or stakes in private companies with significant growth potential (e.g., China and Saudi Arabia);
- *balanced strategy*, prioritizing investments in real estate (e.g., UAE and Abu Dhabi).

University endowment funds also represent a significant block of institutional investors. Their strategies are primarily determined by the pri-

Table 3

Portfolio Structure of the Top-3 Largest Hedge Funds by Mid-2024, %

Fund	Equities	Bonds	Alternative Assets	Cash & Cash Equivalents
Bridgewater	30–35% (broad diversification across regions and sectors)	40–50% (U.S. Treasuries, corporate bonds, emerging market bonds)	15–25% (commodities, gold, currency positions, derivatives)	5–10% (high cash allocation for portfolio rebalancing)
Renaissance	50–60% (high-turnover trading)	10–15% (includes short positions, arbitrage strategies)	25–30% (currency pairs, commodity futures, options, derivatives)	<5% (minimal, as funds are constantly in circulation)
Citadel	40–50% (long- and short-term investment strategies)	20–30% (corporate bonds, structured products, derivatives)	20–30% (futures, options, credit derivatives, volatility trading)	5–10% (cash instruments for portfolio rebalancing)

Source: complied by the authors.

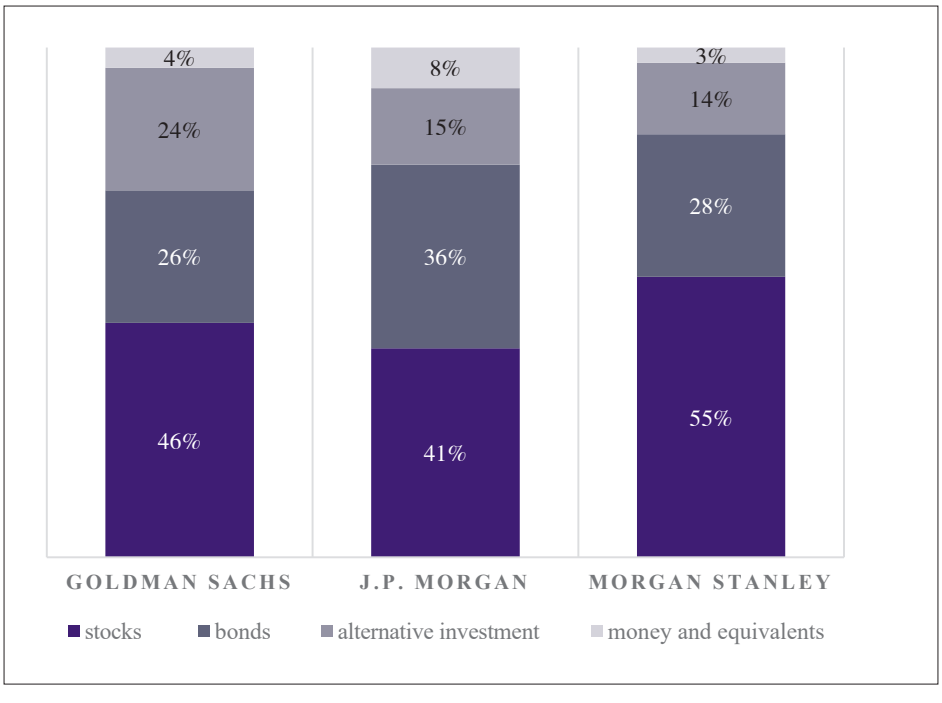

Fig. 2. **Portfolio Composition of the Top-3 Largest Investment Banks by Asset Categories, Mid-2024**

Source: complied by the authors.

orities of the institutions they support. Yale and Stanford, for instance, follow distinctive strategies aimed at high average annual returns but entail higher risk. Yale's endowment portfolio allocates up to 75% of targeted capital to alternative assets, including hedge funds, venture capital (startups), real estate, and direct investments. Harvard's approach generates slightly lower returns but emphasizes broader diversification and active asset management. The asset structure of the top three largest university endowment funds by category is shown in *Fig. 3*.

Table 4

Portfolio Structure of Major Sovereign Wealth Funds, First Half of 2024, %

Sovereign Fund	Equities	Bonds	Alternative Assets	Private Ownership	Cash & Cash Equivalents
Norwegian Government Pension Fund Global (Norway)	65–70	25–30	5–10	<5	~3
China Investment Corporation (China)	40–50	20–30	20–30	5–10	~5
Abu Dhabi Investment Authority (UAE)	35–45	25–35	20–30	10–15	<5
Saudi Public Investment Fund (Saudi Arabia)	50–60	10–20	30–40	5–10	<5
Singapore GIC (Singapore)	45–55	25–35	10–20	5–10	<5

Source: complied by the authors.

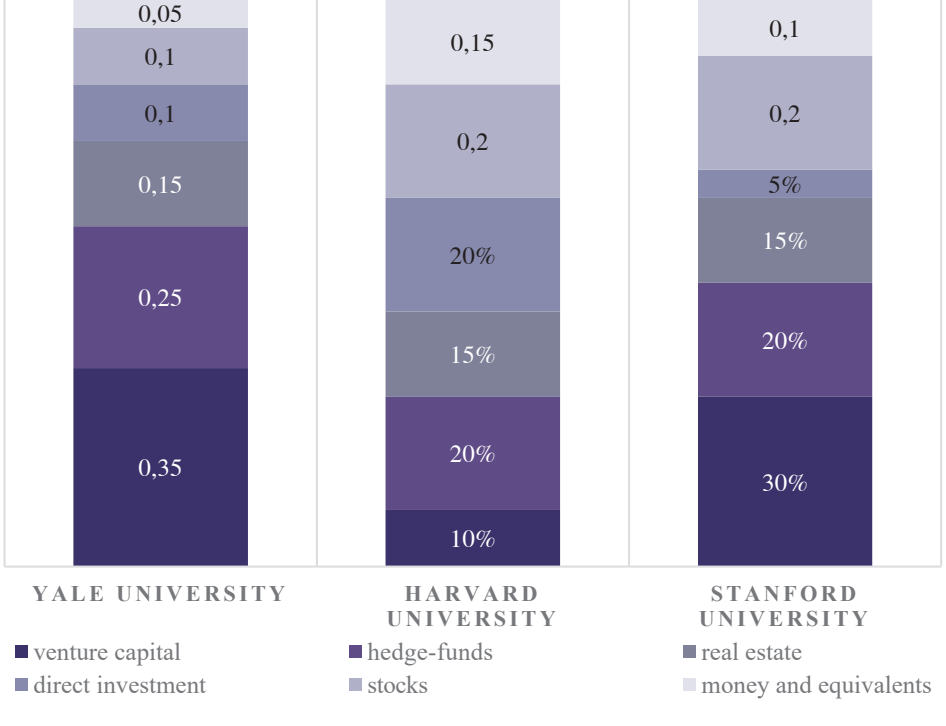

Fig. 3. **Portfolio Breakdown of the Top-3 Largest University Endowment Funds by Asset Classes, Mid-2024**

Source: complied by the authors.

If you want, I can also translate the table/figure descriptions for the endowment funds so the section reads smoothly for an English-language report.

Thus, in conditions of high volatility, each type of institutional investor followed its own portfolio strategy, aligned with its objectives and risk profile. Sovereign funds and pension funds focused on maintaining stability in domestic economies and achieving long-term goals, sometimes even prioritizing stability over returns, whereas hedge funds, on the other hand, aimed to maximize returns amid uncertain expectations, employing more aggressive investment strategies.

TYPOLOGY OF MODERN INVESTMENT STRATEGIES

Modern institutional investment strategies are based on in-depth analysis of macroeconomic indicators, broad diversification, and systematic risk management. The analysis shows that approaches to building a portfolio capable of generating stable returns differ among investors, but depending on the primary investment strategy, they can be broadly categorized into four types:

1. *Risk-parity strategy* (also known as "All-Weather Investments") [16], which involves distributing risk across different asset classes so that the portfolio can "weather" any macroeconomic scenario (*Table 5*). Investors adopting this strategy often use leverage to balance the risks of low-volatility assets.

The fundamental principle of this strategy is that different asset classes respond differently to dynamic changes in macroeconomic indicators, which creates a resilient portfolio over the long term.

2. *Active macroeconomic investing*, or the Pure Alpha strategy, aims to generate alpha — returns above the market — by analyzing macroeconomic factors (see *Table 6*).

This strategy, named after the fund that pioneered it, is one of the most successful in the world, historically delivering high returns while maintaining a controlled level of risk.

3. *Barbell Strategy*, which involves allocating assets between two extreme risk categories [17] (see *Table 7*).

In this case, the portfolio takes a "barbell" shape, with conservative, low-risk assets concentrated on one side to protect capital and provide stable returns, and high-risk, potentially high-return investments on the other side to generate outsized profits. This approach can achieve very high returns (for example, similar to Medallion, discussed above) but also creates the possibility of losing the initial capital. Such a strategy is often employed by leading financiers like Martin Ford, Nassim Taleb, and others — particularly during periods of market instability.

4. *Liquidity Tiers Strategy* — a tactical liquidity management approach to asset allocation, widely used by institutional investors in 2022–2024. It involves diversifying assets across three tiers based on liquidity and investment horizon [18] (see *Table 8*).

This approach allows for the optimal allocation of capital among short-term, medium-term, and long-term assets, ensuring both liquidity and growth. It is particularly effective for funds with long investment horizons and substantial obligations, such as university endowments and pension funds.

CONCLUSION

The study shows that in the high-volatility environment of 2022–2024, institutional investors actively adapted their asset management strategies, employing a wide range of tools to maintain a balance between return and risk. In the context of global economic and geopolitical changes, traditional principles of diversification and hedging proved insufficient for ensuring portfolio stability, prompting the development of comprehensive solutions incorporating risk-parity, barbell strategies, dynamic liquidity management, and other approaches.

The choice of a specific strategy depended on key macroeconomic indicators (inflation, interest rates, etc.), geopolitical trends (sanctions, energy crises), and dynamic changes in alternative asset markets (cryptocurrencies, venture investments).

Retrospective analysis by the authors revealed that pension funds and sovereign wealth funds

Table 5

Typical Risk Parity Portfolio Composition

Asset Class	Share, %	Role in Portfolio
Long-term bonds	40	Crisis protection, fixed income
Medium-term bonds	15	Balance between return and protection
Equities (stocks)	30	Capital growth during periods of economic expansion
Commodities	7.5	Inflation protection
Precious metals	7.5	Protection against currency and geopolitical risks

Source: complied by the authors.

Table 6

Typical "Pure Alpha" Portfolio Composition

Asset Class	Allocation, %	Role in the Portfolio
Equities	25–35	Geographic diversification, alpha generation
Bonds	30–40	Defensive assets with stable income (U.S. Treasuries, European and Japanese government securities, corporate debt)
Commodities	10–20	Alpha generation, alternative investments
Currencies and currency derivatives	5–15	Returns from open positions in major global currencies + currency risk hedging
Hedge funds and alternative strategies	5–15	Diversification, risk limitation on open positions (using futures, options, and other derivatives)
Cash and short positions	5–10	Maintaining liquidity, arbitrage strategies, and active risk management

Source: complied by the authors.

Table 7

Typical Barbell Strategy Portfolio Composition

Asset Class	Share, %	Role in Portfolio
Risk-free assets (bonds, cash)	40–50	Risk minimization: US Treasuries, high-grade corporate bonds, money market instruments
High-risk assets (growth stocks, venture capital, crypto, options)	40–50	Alpha generation: tech stocks, startups, cryptocurrencies, volatile ETFs, options
Medium-risk assets (balanced funds, "blue chips")	0–10	These assets are rarely used, as the strategy avoids "middle" options

Source: complied by the authors.

Table 8

Typical Portfolio Composition under the 'Liquidity Tiers' Strategy

Tier	Asset Class	Allocation, %	Portfolio Role
Tier 1 — Highly Liquid Assets	Treasury bonds, cash, short-term money market funds	10–20	Quickly accessible assets to cover expenses and crisis situations
Tier 2 — Medium-Liquidity Assets	Stocks, corporate bonds, public REITs, liquid ETFs	40–50	Form the main part of the portfolio, providing capital growth and returns
Tier 3 — Low-Liquidity Assets	Private equity, venture capital, real estate, infrastructure projects	30–40	Long-term investments with high potential returns but low liquidity

Source: complied by the authors.

adopted more conservative approaches during periods of high volatility, increasing the share of debt instruments, whereas hedge funds and certain investment banks focused on short-term, high-risk operations using derivatives and algorithmic models.

The evolution of investment strategies was driven by institutional investors' desire to increase flexibility and respond rapidly to market shocks. The combined use of risk management tools and active liquidity management helped maintain competitive advantages amid uncertainty.

The study's findings can inform the development and optimization of investment portfolios across various categories of institutional investors and support the assessment of long-term prospects for global financial markets.

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The Development of China's Financial Sector as a Catalyst for Growing Space Industry

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ABSTRACT

The relevance of the article's topic is determined by the current trend of searching for ways to ensure the sustainable development of national space activities and methods of financing them. Along with them, we take into account the emergence of the private space industry and the accelerated overall pace of innovation processes in high-tech sectors of the economy. **The objectives** of this research work is to analyse the most significant transformation stages of financial sector of the People's Republic of China and the impact of this process on the country's achievements in space exploration within the period over the past several decades. The principal method used by the authors is qualitative content analysis, combined with a chronological approach to data systematisation. **The scientific novelty** lies in the combination of several aspects into a single causal field, namely, the development of Chinese financial system, the organisational structure of its space industry, its achievements, as well as the state support measures. **The results** of the study suggest that one of the key factors of success in space exploration of the People's Republic of China could be the combination of market mechanisms with strong elements of a planned economy, which allows for the effective management of investment allocation in this strategic industry. **The practical significance** of the research work insofar, lies in potential application of its results to provide effective instruments for the financial support of high-tech industries, including the space exploration sector. The conclusions obtained may be beneficial for specialists involved in the planning activities and in the implementation of major national projects.
Keywords: China; space industry; financial sector; public administration; project and programme financing; investments; private capital

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INTRODUCTION

The space industry holds a priority position in the state policy of the People's Republic of China (PRC), contributing to a stronger national defence, economic, and scientific-technical potential. It serves as a major source of technological development and makes a multiplier effect on adjacent economic sectors. Over the recent decades, Chinese space industry initially used the Soviet experience and technologies, but later it abandoned a catch-up position in development and become one of the world's leaders. The competent state governance played a pivotal role in it and the priority position in this sector, in the development of national financial sector and diversification of funding sources. Its fast-growing industrial capacity resulted to major changes in domestic economic and financial systems. In this context, the banking sector of China plays a major role: the world's second-largest economy has a developed financial ecosystem with investment opportunities in space projects and expanding access to capital for space enterprises.[1]

This, in turn, contributes to implementing large-scale research projects, developing new technologies, and supporting private initiatives in space exploration, which consolidates China's leadership in the space exploration.

THE HISTORY OF CHINESE SPACE EXPLORATION: FROM BACKWARD SECTOR TO GLOBAL LEADERSHIP

Chinese space industry emerged and developed in specific political, economic, and technological conditions with strong influence of isolation and **lack of** advanced foreign technologies due to embargos imposed by the US and Western world. The primary challenges were techno gap, a lack of skilled experts, low coordination between departments, the absence of a unified strategy, and a limited funding. However, focusing on autonomous development and scientific-technical sovereignty, China has built a technologically progressive space sector.

[1] According to the International Monetary Fund and the World Bank, China takes the second position after the USA in terms of nominal GDP and the leading position in the world ranking in terms of GDP as calculated regarding purchasing power parity.

Many academic studies were devoted to analysis of creation of this sector. Many scholars describe the chronology of basic technical achievements and evolution of the strategy and concepts in the space programme of China [1–3]. Some research address the aspects of growing political influence related to the success in the rocket and space sphere there [4,5]. Foreign scholars also analyse the process of adaption of defence innovations for civilian needs and transformation of management mechanisms for dual-use technologies in this sector [6, 7]. Some researchers specify Chinese state programmes to support scientific studies, experimental R&D, and encouragement of innovations [8,9]. In recent years, many works focused on development of commercialisation process and the role of expanding private space sector in China [10–12]. However, the impact of development of the financial sphere and investment instruments on the sector.

The evolution of the financial sector and space activities of the PRC can be tentatively segmented into four key stages, each of them representing notable institutional and technological transformations.

Stage One (mid-1950s – mid-1970s) is characterised by rigid centralised planned economic system, the appearance of national space programmes oriented on defence. In this period, Chinese economic system represented a uniformity of ownership forms, centralised decision-making in economy, natural resource distribution, equal-opportunity system of income distribution, and isolationism due to the foreign policy. The-then economic model was a planned economy with elements of radical communism policy. An important nature of centralised planned economy was the unity of economic and political systems that manifested in the management by the Party, and this led to distortions in the allocation of resources [13].

Until the mid-1970s, the PRC policy of isolationism from external collaboration and investment affected the development of the space industry. A lack of sufficient state funding for R&D deteriorated the situation as well.

The People's Bank of China (PBC) represented national financial system combining operational functions of central and commercial banks. The

PBC made transactions of financial flows of state institutions, provided banking settlements, cash services, and lending. The operations of other banks and financial entities were rigidly controlled by the state with high subordination to its policy. The list of these banking institutions included:

- *The Bank of China (BOC*), one of the oldest banks founded in 1912, to handle global financing operations, currency transfers, and cross-border trade services.
- *The Agricultural Bank of China (ABC)* was in charge of financing agriculture and development of agrarian sector, provision of loans and services to the peasant farms.
- *The People's Construction Bank of China (later re-named as China Construction Bank, CCB)* was oriented to industrialisation policy financing construction and industrial projects.

This trio of banks operated under a large extent of centralised management and control of the PBC, which limited their functions and opportunities depriving flexible lending and client services [14].

In view of limited financial resources and hard-line centralisation in China, the major efforts to set up and build space industry were made in close collaboration with the military sector intended to develop long-range ballistic missiles for safeguarding national security and creating a strategic nuclear arsenal. In 1956, space industry emerged, when the Fifth Academy of the Ministry of Defence was founded as the first national research institute of rocket technology [15]. Military tasks were of top priority, which influenced the nature of scientific research and technological innovations.

From in the mid-1950s, China waged a large military-and-technical assistance, which led to a strong contribution for the establishment of space industry with provision of samples of missile technology and training of Chinese specialists. In 1960, a breakdown of the bilateral ties gravely affected the progress of the Chinese space industry due to a shortage of qualified personnel and modern technologies. From this time, China relied its state strategy on space exploration with internal technological resources and national funding, autonomously developing its space ecosystem [2].

The centralised funding from the state budget covered all expenses in the space industry. Support programmes were advanced in two directions:

- Funding in the context of development projects of national defence under the control of military and defence-industrial institutions.
- Funding via subsidising scientific research institutions involved in civilian space science, primarily, the Chinese Academy of Sciences (CAS).

In that time, the highlight project of the national space industry was the development of the "*Dongfeng*" ballistic missile series. The major triumph was the launch of the first Chinese satellite, "*Dong Fang Hong 1*" delivered to the orbit by the Chinese launch vehicle "*Long March 1*" [16]. It was symbolic for Chinese technological independence in space exploration. Thus, on April 24, 1970, China became the fifth country in the world, which autonomously launched a satellite into orbit and won the status of a space power [17].

Concurrently, in this period of time China indicated quite a low progress in space landmark developments as a result of external isolation, a shortage of financial, technological, and qualified human resources, as well as internal political instability that negatively hindered the implementation of research and development [18]. Despite the general strengthening of military power, the space programme of China remained largely limited. It was aimed mainly at defence tasks and characterised by backward technological position behind space-oriented world leaders.

Stage Two (Mid-1970s — Late 1990s): A gradual transition from a centralised planned economy to the socialism with market mechanisms and reforms in domestic financial sector, institutional formation, and effective progressive development of independent national space industry. In the late 1970s, the government of the PRC acknowledged the need to reform its national rigidly centralised economy and switch to a new model of economic development, which combined market instruments with political control. In December 1978, the Third Plenary Session of the 11th Convocation of the Central Committee of the Communist Party of China proclaimed the official start of the reform and the policy of transparency.

The import of advanced technologies and equipment was necessary for the modernisation programme of the economy in China. According to assessments of Chinese experts, capital construction investments alone required an amount of approximately 400 billion USD. China recommenced the system of active purchasing equipment from abroad, which, in turn, increased the need of foreign currency resources [19]. Financial limitations posed a grave risk for national modernization plans that prompted the government to pursue the policy stimulating foreign trade and drawing foreign investment into domestic economy. Concurrently, the objective was to make these measures compatible for the achievement of strategic goals for the benefit of the national economy in order to evade defiance between admitting foreign capital and preserving the principle of self-sufficiency.

The desire for global market access external markets and investment sources stimulated transformation of the banking system in China. In 1985, an important initiative was adopted: the State Council Provision "On the Regulation of Foreign Banks and Sino-Foreign Joint Venture Banks in Special Economic Zones". For the first time at the legislative level, this law regulated the presence of foreign banks in the territory of China, however, limiting their activities to the territories of the Special Economic Zones established in 1980: Shenzhen, Zhuhai, Xiamen, Shantou, and later, Hainan Island [20]. Furthermore, as a follow up to the reforms aimed at institutionalising the stock market and strengthening investor confidence, in 1990–1991, two key stock exchanges were established: the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE) [21]. Then in 1992, the China Securities Regulatory Commission (CSRC) was founded as a body subordinate to the State Council in charge of the centralised supervision of stock market participants. In 1994, to deploy a multi-level, diversified banking system with components of the market mechanism, three so-called "policy banks" were established: the China Development Bank (CDB), the Export-Import Bank of China (China Eximbank) and the Agricultural Development Bank of China. They were in charge of relieving other major state banks from targeted financing of state programmes and transforming them into commercial structures to interact with enterprises, the population, and foreign trade on a market basis. In 1996, the PRC government approved provisions for dealing with pilot projects in venture investment, permitting the creation of venture funds on a commercial basis with potential participation of private and foreign investors. This indicated the appearance of the institutionalisation of venture capital as a segment of financial system in China [22].

Accumulating foreign investments for the development and modernisation of industrial production has become one of the major trends in the economic history of China [23]. The banking system strongly controlled by the state, has operated as the principal channel to mobilise the economic development of the industry. The PBC reinforced credit emissions through the state-owned banks and institutions of development in line with the government's indicative plans. In fact, this provided centralised planning of investments, that ensured the allocation of credit resources to develop high-priority sectors [24].

As the Chinese economy became more intricate, the process of lending grew more discerning and the monetary policy turned out more flexible. In the course of growing priority of space research, the budget for these programmes expanded, which allowed developing new technologies and launching more spacecrafts. During this period, Chinese space exploration programme gradually became more transparent and application-oriented. It also revealed a growing interest in international collaboration.

Besides, following the suite of *the US Stevenson-Wydler Technology Innovation Act of 1980,*[2] *the PRC implemented a policy for "civilising mission of military technologies" in the 1980s, using military R&D findings and production potential to manufacture civilian products [25]. In 1986, China launched "The 863 Program", aimed at increasing domestic*

[2] URL: https://en.wikipedia.org/wiki/Stevenson–Wydler_Technology_Innovation_Act_of_1980

competitiveness for the global market and improving the overall R&D capacity in high technology. This made a broad systemic impact on the development of national space industry from the late 1980s throughout the 2000s. "The 863 Program" was financed via the central budget with support of the China's Ministry of Science (MOST)[3] *and the Commission for Science, Technology and Industry for National Defense (COSTIND) primarily through targeted grants. This involved the financing for key laboratories and projects, infrastructure subsidies for upgrading production level, and state orders for specific applied developments provided to contracted R&D institutions [26]. Thus, the development of key space technologies was supported and the funding facilitated the renewal of the R&D base of institutions in the space sector.*

With gradual infiltration of market mechanisms into China's economy, the state was coordinating the application of achieved results, undertook measures to ensure a sustainable development of the space industry [27]. In 1993, the state adopted a decision of systematic management in the space industry: managerial and production functions were separately transferred to the China National Space Administration (CNSA) and the China Aerospace Corporation (CAC), respectively. In 1999, the latter was dissolved and transformed into two entities: the China Aerospace Science and Technology Corporation (CASC), in charge of civilian space projects, and the China Aerospace Science & Industry Corporation Limited (CASIC), responsible for military technologies and their applied use.

These institutional transformations laid the basis for the subsequent progress of the industry, facilitating possible opportunities for the introduction of market mechanisms in certain segments of outer space activity.

During this time-frame period, the national space industry focused on developing launch vehicles and satellites, as well as the basics of future manned spaceflight. In the 1980s, China started actively developing its technologies in satellite communications, meteorology, and navigation:

- In 1975–1980, the *Dongfanghong* (*DFH-2*) communications satellites were produced and in 1984, the first of them was launched into geostationary orbit (followed by others), which was a breakthrough for the national telecommunications infrastructure. Thus, in the 1990s, a unified satellite communications network was assembled covering the territory of China.
- In 1988, the first Chinese meteorological satellite, *Fengyun* (*FY-1A*), was launched improving weather forecasting in China.
- China implements active development of Earth Remote Sensing (ERS technologies).
- China developed and launched the *Fanhui Shi Weixing* (*FSW*) series of recoverable satellites for Earth photography. It became the third country in the world with soft-landing satellites returning from orbit.
- In 1994, China approved and officially initiated the programme to create the *Beidou* navigation satellite system.
- Gradual deployment of the launcher vehicle series *Long March* for placing payloads into different types of orbits.
- In the 1990s, intensive knowledge and experience was gained for developing a manned space programme that culminated in the successful launch of the *Shenzhou 5* spacecraft, thus, China became the third nation after the USSR and the USA to launch a cosmonaut in outer space using its own autonomous system [28].

In 1985, China officially announced its plans to provide launch services on the global market with *Long March* launch vehicles (an important step towards the commercialisation of space activities, which contributed to the further growth of funding for the outer space programme). Besides, growing market-based financing mechanisms facilitated access for Chinese space companies to funding not only from the state but also from the society. Thus, IPOs were listed on the stock exchange by subsidiaries of the state corporation CASC: China Aerospace Times Electronics Co., Ltd. (in 1995, it financed the development of satellite electronics and microsystems) and China Spacesat Co., Ltd. (in 1997, it attracted funds for developing ERS

[3] Prior to the year of 1998, The State Science and Technology Commission was the predecessor of The Ministry of Science and Technology in China.

and telecommunication technology satellites). Concurrently, the key funding source for space programmes remained allocations, including the sponsorship of academic institutions, ensuring central control and resource allotments. The key growth factor served as state investment.

Thus, in that time, China executed large-scale economic reforms (including in the financial sector), but their impact on the space industry was still small. The space industry remaines a strategically sensitive and secret sphere, closely linked to the military industry, but its practical application gradually developed. The state controlled funding for strategic industries carried out mainly beyond market mechanisms occurs through the state budget, sectoral planning, and defence programmes. Concurrently, China devises financial markets, greenlighting companies to raise funds directly from the society and involving market mechanisms. In the 1990s, the PRC initiated offering launch services on the global market as the first step towards the monetizing of its outer space activities. Henceforth, the PRC gradually transformed from a catching-up nation into an independent space power.

Stage Three (Late 1990s — Early 2010s): Integration into the global financial system and hitting the world market of space services and technologies. At the early stage of attracting foreign investment, the main goal of Chinese policy was a compensation of drastic lack of foreign currency. As competitive benefits, it offered a high level of services, a variety of financial products, competence in fulfilling innovations and new services, as well as successful asset and liability management.

However, China's entry into the WTO in 2001 was a turning point in the liberalisation of the financial sector. By the year of 2006, the PRC closed its obligations to the WTO, completely opening its banking market to world players. Therefore, foreign banks gained the permission to operate in the PRC like the local banks, providing a wide range of services in yuan without any restrictions related to service territory or client type [19, 20]. Besides, in 2002, China launched the programme *Qualified Foreign Institutional Investor*, which allowed foreign institutional investors within established quotas to purchase Class A shares, bonds, and other securities traded on the Shanghai and Shenzhen exchanges paying in yuan through custodian accounts in eligible Chinese banks.

The growth of the stock market, stimulated by the inflow of foreign capital, reinforced the Chinese financial system, including banks, which, in turn, could support projects in strategic sectors. Moreover, from the late 1990s to 2010, China carried out a thorough reform in largest state-owned banks BOC, ABC, CCB, as well as the Industrial and Commercial Bank of China (ICBC) founded in 1984. The transformation involved revitalisation, corporatisation, and entry into global stock markets. Each of them conducted IPOs jointly with major foreign investors, thus, it attracted billions of dollars and transformed the banks into modern financial institutions integrated into the world-wide financial system.

Concurrently, in 2006, China adopted the first ever comprehensive state document for strategic planning in science, technology, and innovation *"National Medium-and-Long-Term Program for Science and Technology Development (2006–2020"*. Its goal was to create an innovation-oriented economy. Outer space activity was included in the list of priority high-technology venues of key significance for national development and global competitiveness. The given programme indicated the following strategic benchmarks: building national and regional innovation system, support for the interconnected development of defence and civilian technologies, fostering enterprises to increase R&D expenditures, development of international collaboration in science and technology, and enhancement of the potential of exported Chinese high-tech products. The plans for state-support mechanisms to implement this policy included the following directions:

Active improvement of the system for organising investment and financing in science and technology, refinement of the venture investment mechanism for innovation and pioneering activities, creation of platforms for financial cooperation in science and technology in various forms.

- Attraction of high-tech enterprises to listings visible on stock market platforms.

- Provision of more agreeable banking and currency environment for high-tech venture companies.
- Provision of preferential loans by banking institutions for major national industrial projects in science and technology, as well as for their commercialisation projects.
- Encouragement of enterprises to set up special funds aimed for financing R&D.
- Government procurement activation of scientific and technological resources throughout the country using various financial mechanisms, such as direct appropriations and tax incentives.[4]

Under these conditions, the state funding for space industry increased substantially: by 2013, China took the second top-list global position in terms of volume after the USA.[5] At the same time, budgetary planning increasingly aggregated with elements of market logic in the light of transformation of the financial sector within the framework of mechanisms attracting and allocating funds. Primary funding is still allocated as a directive from the state budget. However, a number of departments in charge of scientific, technical, and industrial policy, *MOST, COSTIND, the Ministry of Industry and Information Technology (MIIT),* and *the National Development and Reform Commission (NDRC)*, started introducing market-oriented approaches to resource allocation related to dual-use technologies and civilian high technologies.[6] This has been revealed in competitive selection, evaluation of potential civilian returns, commercialisation subsidies, guidance on preferential lending through state banks, support for clusters of technology, and partially, in co-financing requirements. Thus, CASC and CASIC operated within the framework of a hybrid model where command and market mechanisms concurred with support for efficiency, innovation, and an element of competition [29].

Furthermore, the space industry utilised investment instruments through state and public private banks. Thus, during this period, China initiated implementation of ready-to-use export projects for satellite production and their launch, construction of ground infrastructure, and personnel training (in particular, for Pakistan, Venezuela, Nigeria, Bolivia), subsequently, becoming an alternative to Western and Russian suppliers. Export was backed up by financial instruments from the state banks *Exim Bank* and *CDB*, which provided foreign countries with long-term tied-preferential loans (usually with an interest rate of 2–3 per cent for a 5-year forbearance extra-time period). Primarily, due to the provision of such flexible financing, the PRC is preferable as a partner for space projects among the Global South countries [29].

It is worth noting that by the year of 2011, space sector in China was officially regarded as an economic, not just science and defence sector. This is indicated by core strategic documents (the 3d White Paper "China's Space Activities in 2011" and "The 12th Five-Year Plan for National Economic and Social Development (2011–2015)", which directly defines a course towards the commercialisation of space technologies and recognises the role of the market in managing space infrastructure.

Within this time-frame period, the Chinese space programme achieved a notable success in:

- the sphere of manned spaceflight using *Shenzhou* spaceship (spaceflight with cosmonauts, multi-day orbital manned docking flights);
- the area of orbital station construction (*The Tiangong-1* experimental module launched in 2011);
- the national lunar programme carried out with the *Chang'e* series of spaceships created and launched;
- Chinese *Beidou* navigation grouping was launched and deployed;
- The *Long March* vehicle series were furthermore developed successfully, moreover, from 2001 up to 2013, the launch-to-orbit success rate increased, reaching 98 per cent [29];
- launches of a large number of scientific, technological, and application-use satellites.

Such transformation of the funding concept for high-tech organisations made a positive impact

[4] URL: https://www.itu.int/en/ITU-D/Cybersecurity/Documents/National_Strategies_Repository/China_2006.pdf

[5] URL: https://www.oecd.org/en/publications/the-space-economy-at-a-glance-2014_9789264217294-en.html

[6] Since 2008, COSTIND was transformed in The State Administration for Science, Technology and Industry for National Defense (SASTIND).

on the development of Chinese space industry. As the leading role of state investments remained, gradually there occurred their market-oriented redistribution of support. Currently, the commercial component of Chinese outer space activities grows due to the activity of state corporations. This period can be defined as a transitive one — from exclusively state-centralised to a more application-oriented regulatory model of management with market elements.

Stage Four (2010s – present): Liberalisation of access for non-state actors to outer space activities and the use of market tools of the financial-investment ecosystem for support of commercial space industry. Until 2014, all activity of the space industry in the PRC was under the auspice of the state corporations CASC and CASIC. However, in the context of the emerging global *New Space* phenomenon, the Chinese government began considering the development of its own similar direction in the space industry.[7] A perception appeared, that the space industry had reached such a level of development where the actual involvement of the private sector was not only helpful but quite necessary in order to generate a sustainable space ecosystem, enhance the level of technological innovation, and competitiveness.[8]

In 2014, the Chinese Government adopted "Guidelines of the State Council on Innovation of Investment and Financing Mechanisms in Key Areas and Encouraging Social Investment", also entitled "Document No. 60". It postulated new measures of the policy encouraging the attraction of private capital to ensure growth in seven areas, including civilian outer space infrastructure.[9] This document can be regarded the legal starting point for the encouragement of the rise of Chinese free-enterprise space sector.

"Document No. 60" was reinforced by the administrative issue of "Medium-and-Long-Term Development Plan for National Civil Space Infrastructure (2015–2025)" issued in 2015. It established that all investment enterprises involved in creation and operation of basic space infrastructure would mainly remain under the state control, however, they are permitted and stimulated for private investment in applied commercial projects, which are related to civilian space objects.[10]

Subsequently, other documents on the policy emerged to encourage private investment in the previously closed sphere of space industry. Currently, Chinese private space companies officially receive state support and are able to do the following:

- Use existing infrastructure of space destination (testing grounds, launch pad complexes).
- Operate within the framework of state techno parks and innovation clusters with standard benefits for residents.
- Gain support from central and regional authorities through officially published plans and regulatory documents.
- Attract venture private and public-corporate financing (through various funds);
- Raise venture private and state-corporate financing (by means of various funds).
- Take part in national strategic initiatives and receive state orders.

Notably, the New Space phenomenon in China has an important characteristic of the development. Apart from the support scheme of the central government for a small number of commercial companies, financing of the private space sector by the central government within the framework of R&D funding or product and service contracts is smaller, than financing provided from provincial governments, that strive for regional economic and technological development (*Fig. 1*).

Many representatives of regional authorities are

[7] New Space is a new stage or phenomenon in the development of outer space activities, where commercial players apply innovative business approaches and financial mechanisms, leading to technological breakthrough innovations, reduction of the costs of access to outer space, and expansion of the number of participants in the space sector.

[8] New Space in Asia — Experts views on space policy and business trends in Asian countries. European Space Policy Institute, report 77. 2021. 128 p.

[9] URL: http://www.gov.cn/zhengce/content/2014–11/26/content_9260.htm

[10] URL: https://www.ndrc.gov.cn/xxgk/zcfb/ghwb/201510/W020190905497791202653.pdf

convinced that the aerospace industry positively influences other economic spheres, they understand its strategic significance, and regard its development a clear indicator of the general industrial power of a district [30]. Meanwhile the central government develops macro-plans for space exploration, local authorities back up private space enterprises and entities via complementary symbiotic relationships facilitating regional development and the growth of technological innovations in a stable financial environment [31]. Such support for the New Space era can be regarded as one of the key factors for its prosperity in China: private space projects are often financed through investment funds of provinces and cities.[11]

As Chinese commercial space companies build up, the issue of their ability to list their shares to the IPO market became relevant, which has always been difficult in China due to tough listing rules. However, in 2019, this procedure was simplified with the foundation of *The Science and Technology Innovation Board* (*STAR Market*). The latter is a branch of the *Shanghai Stock Exchange* that facilitates IPO listing for Chinese early-stage high-tech companies with no stable profits (particularly in the sphere of AI, commercial space, and low-orbit economy projects).[12] One of the first entity, which filed to list its shares on IPO's *STAR Market* was the state-private satellite company *PIESAT Information Technology*. This has become a clear signal of a possibility for implementing a mechanism for attracting venture capital and direct investment in the industry.

It is worth mentioning that, despite liberalisation and the active use of market mechanisms, foreign companies still cannot freely invest in sensitive industries, including the Chinese space sector. In 1995, the government PRC for the first time issued "The Catalogue of Industries for Guiding Foreign Investment".[13] In 2017–2019, it stipulated items related to the space industry, including the design and production of civilian satellites, their payloads, components, and testing equipment, as well as R&D of innovative space materials. However, despite the unified PRC "Foreign Investment Law" adopted in 2020, which formally guarantees foreign investors market access and business activities, the abovementioned Catalogue contains *"The Negative List"* that indicates the industries with limited or prohibited access. The List includes certain segments of the space industry, for example, the access to the sphere of Earth Remote-Sensing satellites (ERS) is banned for foreign investments without special corresponding permission from the competent authorities of China.[14]

Chinese private space enterprises are predominantly financed through internal sources: private investors, as well as private, state, corporate, academic, and mixed venture funds. Active private venture funds are *MPC* (formerly known as *Matrix Partners China*), *Shunwei Capital, Source Code Capital, HongShan* (alias *Sequoia China*), and CDH Investments. Subsidiaries of state space corporations more often receive resources from corporate investment platforms, affiliated state banks, university funds, as well as state funds (central government and Chinese provincial funds) [32]. We distinguish some of them: *CASIC Fund*, *Guochuang Investment Guidance Fund* (a large national Fund of the Funds" set up in 2017 by several state structures), *CAS Star* (the foundation of the Chinese Academy of Sciences), and the state fund *National Manufacturing Transformation and Upgrade Fund*. As regards municipal funds, the list of examples includes *Beijing Commercial Space and Low-Altitude Economy Investment Fund* (Beijing), *Hainan Free Trade Port Aerospace Industry Fund* (Hainan), and *Hubei Yangtze Aerospace Equity Investment Fund* (Hubei).

The abovementioned processes facilitated introduction of wide development of a public-private partnership model in the industry and significant changes in the image of Chinese space sector. Since 2015, over the recent ten years, the amount

[11] New Space in Asia — Experts views on space policy and business trends in Asian countries. European Space Policy Institute, report 77. 2021; 128 p.

[12] URL: https://paper.people.com.cn/zgjjzk/pc/content/202506/30/content_30084872.html

[13] URL: http://www.gov.cn/xinwen/2019–06/30/5404701/files/9d2dde75fa054d249dfa16267af42277.pdf

[14] URL: https://www.ndrc.gov.cn/xxgk/zcfb/ghxwj/202504/P020250424307430450848.pdf

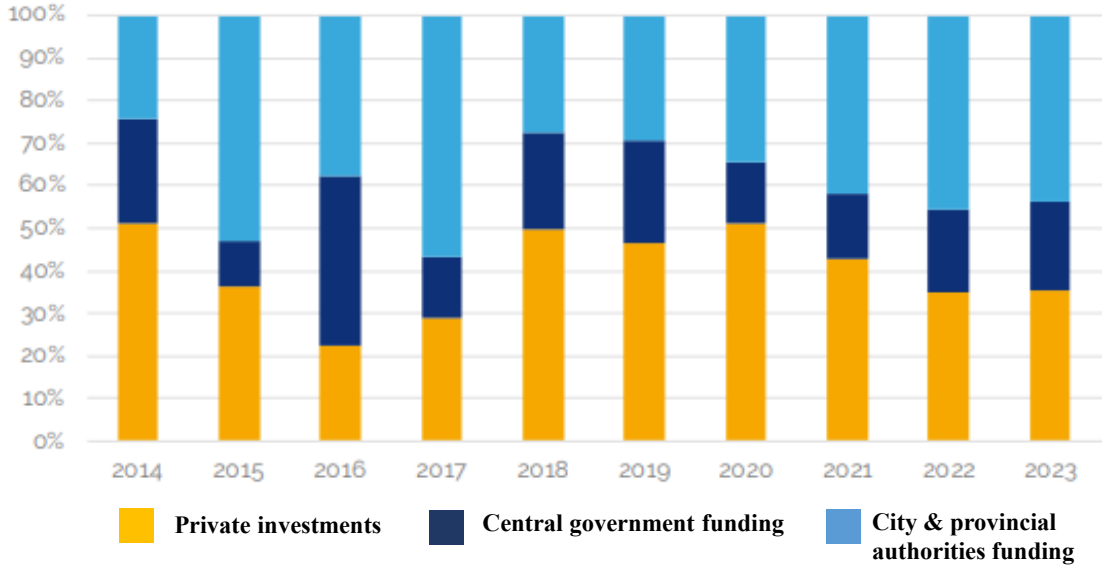

Fig. 1. **Funding of Commercial Space Activities in China by Source Type, 2014–2023**

Source: compiled by the authors: URL: https://www.espi.or.at/wp-content/uploads/2024/05/ESPI_Space_Venture_2023.pdf /

of commercial space companies in the PRC increased to several hundred. Nowadays, developed, institutionally established mechanisms for the functioning of the financial sector, a significant amount of various venture funds, the growth of direct investment volume have become the factors of positive influence on Chinese *New Space*, which was actively operating with investments starting from the year of 2017. From 2014 to 2023, over 7.5 billion euros was invested in companies in the sector.[15] In 2024, Chinese space start-ups attracted a record volume of funding: 1.9 billion USD (24 per cent of the total private investment globally in space start-ups). Based on this index, the PRC took the second leading position in the world to follow only the USA (*Fig. 2*)

Compared to 2021–2023, it is observed a significant growth in investments, as a result of support for Chinese private launch service providers, as well as manufacturers and operators of planned satellite mega-constellations.[16]

Commercial players operating successfully to secure funding resources are the following:

- launch vehicle developers *Galactic Energy*, *OrienSpace*, *LandSpace*, *Space Pioneer*, *iSpace*.
- satellite manufacturers *MinoSpace*, *GeneSat*, *Commsat*;
- provider of ground segment satellite communication equipment and service *EmpoSat*;
- the ERS operators *Chang Guang Satellite Technology*, *ADA Space*, *Spacety*;
- the state-private space project *SpaceSail* creating a large orbital constellation for providing satellite broadband, it is considered a future competitor to *SpaceX's Starlink.*[17]

In addition to developing private domestic spaceflight, China simultaneously increased the budget to implement state space programmes: during the period under study, the budget more than tripled from 6 billion USD in 2013 to nearly 20 billion USD in 2024.[18] The PRC established the development of space technologies as a main priority and made gross investments in space activities, implementing policy initiatives in the industry. So, in the last decade, China has got the following big success:

[15] URL: https://www.espi.or.at/wp-content/uploads/2024/05/ESPI_Space_Venture_2023.pdf

[16] URL: https://brycetech.com/reports/report-documents/start_up_space_2025/

[17] How Subnational Government Support is Helping China Build Its Version of Starlink. Asia Pacific Foundation of Canada, 2025. URL: https://www.asiapacific.ca/publication/subnational-government-support-china-satellites-and-space

[18] URL: https://www.weforum.org/stories/2016/10/china-space-programme-tiangong-numbers/ |World Economic Forum; URL: https://nova.space/press-release/defense-spending-drives-government-space-budgets-to-historic-high/

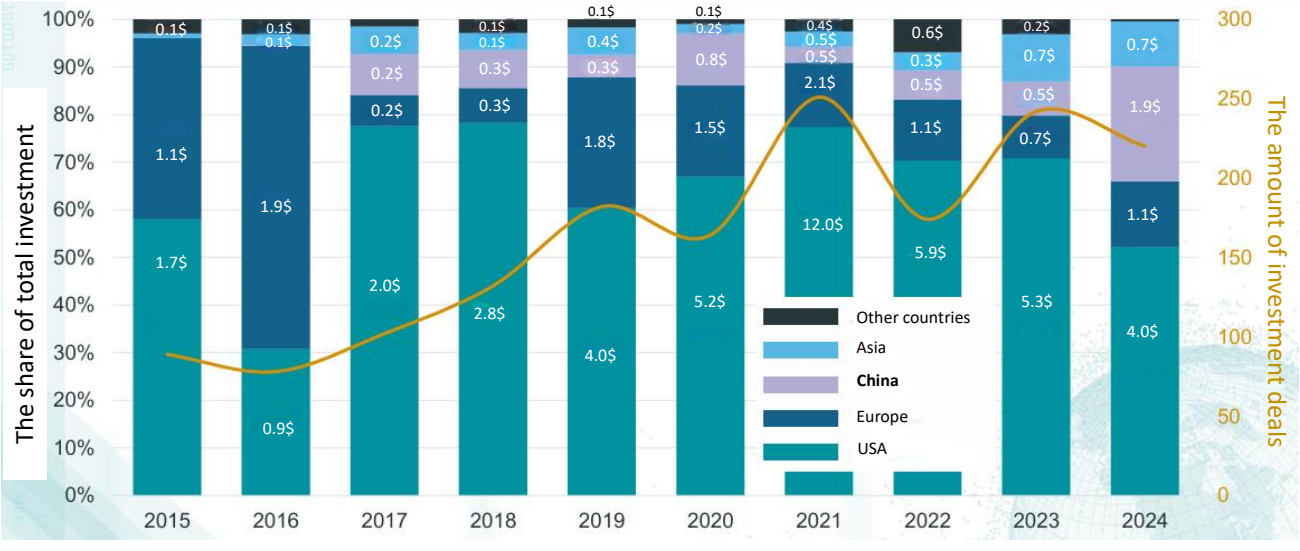

Fig. 2. **Geographical Distribution of Private Investment in Space Start-Ups for the Period of 2015–2024, in Billion US Dollars**

Source: compiled by the authors: URL: https://brycetech.com/reports/report-documents/start_up_space_2025 /

- a technological breakthrough by launching *Mozi,* the world's first quantum communication satellite in 2016;
- in 2019, China became the first in the world to accomplish a soft landing of the *Chang'e-4* apparatus on the other side of the Moon, later, in 2021, the second country in the world after the USA when successfully landed its *Zhurong* rover on the surface of Mars for its interplanetary mission *Tianwen-1*;
- in 2020, China deployed the 3rd generation of the *Beidou* navigation system, providing global coverage;
- by 2020, the state high-precision *Gaofen* observation system was in operation, providing 24-hour all-weather Earth monitoring;
- since 2015, China started to deploy *Jilin-1*, the largest national ERS commercial satellite constellation with over 100 apparatuses;
- in 2022, the multi-module space station *Tiangong* was completed, since 2023 manned missions were launched with *taikonauts* who stayed in the station for months;
- China strongly expanded its presence in orbit: by early 2025, its total satellite constellation included over 1,050 active apparatuses, which ranks second in number after the USA. As compared to 2015, the amount of Chinese satellites in orbit has grown more than six fold[19];
- In 2018, the PRC launched the record number of space ships in a single year, and since then it has considerably outmatched at the first or second top-list position by this indicator, by increasing launch vehicle launches from 19 in 2015 to 68 in 2024.[20]

Such a space success is based on China's achievements in rocket technologies, allowing for the reliable launches of payloads into various orbits. Qualitative launch vehicles can be viewed as an indicator of growing space potential achieved with considerable technological progress in this field. It is possible that private companies will furthermore contribute to this success. In 2023, they demonstrated initial results: *LandSpace* conducted the world's first successful launch of a methane-liquid-and-oxygen-fueled rocket placing a payload into low orbit.[21] Chinese *New Space* companies open the doors for innovation and technological progress beyond the state entities and allow for reducing potential dependence on foreign suppliers of space components [31, 33].

[19] URL: https://ts2.tech/en/inside-chinas-space-empire-satellites-services-and-the-secret-power-of-cnsa/

[20] URL: https://aerospace.csis.org/data/space-environment-total-launches-by-country/

[21] URL: https://www.landspace.com/en/news-detail.html?itemid=15

Thus, the measures of the PRC in the state industrial and technological policy to back up the private space industry (incl. the issuance of directive documents, creation of institutional mechanisms, including financial, to raise non-state investment into the industry, implementation of direct and indirect funding) lead to building a hybrid model of the national space industry. Thus, private companies jointly reinforce the national space programme, the synergy of the state and private sectors contributes to innovation and increases the development of the space industry. Nowadays, notable progress confirms China's position of a leader in space, capable of challenging its competitors.

CONCLUSIONS

The rapid progress of China in space is not easy to explain by a single reason: the phenomenon should be viewed as the result of functioning of the ecosystem with a combination of stimulating and supporting factors. One of them is the effective use of the national mechanisms of financial sector. At the early stage, the space programme faced many problems, incl. lack of funding and tech gap. Reforms in the financial sector via transformations in the banking system, development of stock platforms, and activating venture investment, as well as gradual opening to external markets allowed the following:

- Raising international capital, strengthening the financial system and economy, and, as a result, enhancing opportunities for growing funding for technological development and fulfilling ambitious projects in space activities.
- The use of market-driven approaches of financial support for space companies by listing shares on exchanges, preferential lending, switching to a project approach for subsidies and grants, requirements in co-financing etc. fit well with directive state financing of the space industry. Notably, an important role in supporting space industry play a developed national system of state (both central and municipal governments), corporate, private, and mixed venture foundations.
- Securing opportunities for operation in the sector for private companies, contributing to commercialisation and growth of innovation of the industry. These companies count on provided mechanisms of direct and indirect financing from the state and can also use the financial approaches to the stock and venture markets to raise private capital to launch, develop, and expand their activity.

Currently, China's feats in space exploration cover all key directions, from satellite launches to manned flights or comprehensive space scientific research, which is one of the main factors of the global political influence of China. A growing capacity in this sphere is facilitated by a strict political will, strategic priority policy of the government, and large state and private investments, which are ensured by a competent use of mechanisms of Chinese financial sector in the development policy of the space industry.

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Integration of Climate Risks into Corporate Sustainability Strategies: A Case Study of Companies in the Aquaculture Sector

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ABSTRACT

Subject. The article addresses the integration of climate risks into corporate sustainability strategies, using the example of publicly listed companies in the aquaculture sector of Russia and Norway. **Objective.** To compare Norwegian companies (Mowi, Lerøy, and Grieg Seafood) with the Russian company INARCTICA in terms of the presence of sustainability strategies, identification and management of climate risks, and the existence of a dedicated governing body on the board of directors; and to systematize climate risks for companies operating in the Arctic region according to the classification standards of the Task Force on Climate-related Financial Disclosures (TCFD). **Results.** The study finds that Norwegian companies demonstrate higher maturity in managing climate-related risks. **Practical significance.** It is recommended that Russian companies enhance their sustainability strategies by conducting a qualitative assessment of climate risks in line with TCFD standards. The article outlines risk mitigation measures based on best international practices.

Keywords: sustainable development; corporate governance; climate risks; ESG strategy; climate reporting; TCFD; climate adaptation; aquaculture; low carbon development

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INTRODUCTION

According to reports by the World Economic Forum, environmental and climate-related risks have consistently ranked among the top global risks for several consecutive years. In 2025, risks associated with extreme weather events fell to second place behind armed conflicts. Nevertheless, in a ten-year perspective, they occupy the top four positions among the most significant risks — namely: extreme weather events, loss of biodiversity, depletion of natural resources, and anthropogenic environmental pollution (ecosystem degradation[1]).

Combating climate change requires multilateral coordination of efforts at the international level, including within regional intergovernmental organizations. Thus, at the BRICS Summit held in Brazil in July 2025, the member states reaffirmed their commitment to the UN Framework Convention on Climate Change, while emphasizing the need to uphold the principle of "common but differentiated responsibilities and respective capabilities, taking into account different national circumstances.[2]" In this context, Russian companies have been adapting their ESG strategies to the evolving political and economic realities.

According to a 2024 study by the B 1 Group, 72% of large organizations have already revised or plan to update their sustainable development goals, focusing on national regulation, decarbonization, local supply chains, and reporting in line with Russian requirements. Nevertheless, there remains a strong interest in international standards (GRI, TCFD, ISSB), which underscores the strategic value of ESG tools for accessing the Asia-Pacific and MENA markets, as well as their importance for enhancing resilience and investment attractiveness.[3]

Against this backdrop, risks associated with the introduction of the Carbon Border Adjustment Mechanism (CBAM) by the EU and the UK have become increasingly relevant [1]. Despite the ongoing international debate surrounding this measure, Russian businesses are paying growing attention to climate risks and threats. Unlike financial or geopolitical risks, climate-related risks cannot be neutralized through local managerial decisions or short-term diversification. They require a comprehensive approach that includes both technical mitigation measures and the strategic adaptation of business models to changing environmental conditions.[4] Disclosure of ESG criteria — including climate-related risks — has a positive impact on financial performance [2]. In this context, the environmental component of ESG becomes a key factor of resilience, while climate risk management emerges as an integral part of long-term strategic planning [3].

This issue is of particular importance for industries whose activities directly depend on the quality and stability of the natural environment. Among these is aquaculture — a rapidly developing sector both in Russia and abroad. According to a UNEP,[5] report, the impact of climate change on aquatic ecosystems has already become systemic, affecting both biota and infrastructure. Research published in Nature Sustainability[6] has shown that more than 90% of global aquaculture sites are exposed to significant climate-related risks, including rising water temperatures, increasing parasitic risks, oxygen depletion, and instability of hydrological regimes [4, 5].

Nevertheless, despite the high vulnerability of the sector, most Russian companies have yet to demonstrate a mature strategy. Climate risks are generally not identified as a separate category in corporate reporting, are not quantitatively assessed, and are not disclosed in accordance with the standards of the Task Force on Climate-related Financial Disclosures (TCFD), the Carbon Disclosure Project (CDP), or the Science Based Targets initiative (SBTi). In this context, the question of Institutionalization climate risk management in Russian practice becomes particularly relevant, as does the adaptation of best international practices under conditions of limited regulation and methodological uncertainty.

[1] URL: https://www.weforum.org/publications/global-risks-report-2025/

[2] URL: https://tass.ru/mezhdunarodnaya-panorama/24444363

[3] URL: https://b1.ru/analytics/b1-esg-trends-survey-2023/

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[5] URL: https://wedocs.unep.org/bitstream/handle/20.500.11822/45915/Executive-Summary-Foresight-Report_RU.pdf

[6] URL: https://www.ey.com/no/en/services/sustainability/climate-risk-in-aquaculture)

The current political and economic environment — including sanctions and limited access to international sustainable finance — requires a rethinking of ESG strategies within the Russian context. Despite these challenges, ESG approaches remain highly relevant, as they contribute to managing sanctions-related risks, strengthening stakeholder trust, and enhancing the internal resilience of companies. National rating agencies, such as ACRA, have adapted their methodologies to align with Russian regulatory realities, introducing an ESG rating scale (ESG-AAA to ESG-C) and an assessment of ESG maturity levels.

John Elkington's concept of corporate sustainability defines a corporation through the 3P model — People, Planet, Profit — whose elements form a symbiotic relationship [6,7]. This approach has become a standard framework for preparing corporate sustainability reports based on the disclosure of ESG factors.

The term ESG was first introduced in the report Who Cares Wins[7] and is commonly used to describe the performance criteria of corporations [8]. Companies that integrate ESG factors are better positioned to manage operational and environmental risks and are less likely to face technogenic incidents resulting in financial losses or a decline in corporate value [9].

As evidenced by analyses conducted by the International Association of Credit Portfolio Managers (IACPM)[8] and the global audit and consulting network KPMG[9] in 2022 and 2025, respectively, environmental and climate risks have become an integral part of market, reputational, and credit risk assessment. Companies and financial institutions worldwide are adapting their internal structures, developing specialized risk assessment models, and strengthening corporate governance in the field of sustainability — reflecting the shift of ESG considerations into the category of mandatory elements of corporate strategy.

APPROACHES TO THE DEFINITION AND CLASSIFICATION OF ENVIRONMENTAL AND CLIMATE RISKS

Recent studies in the domain of corporate sustainability strategies have indicated a mounting emphasis on the incorporation of climate risks into management systems. In particular, M.A. Izmailova [10] and N.V. Pakhomova et al. [11] emphasize the role of ESG strategies as a key tool for enhancing corporate resilience.

A separate body of research is devoted to the study of climate risks. For example, Z. Korzeb and co-authors identified a low level of attention to this topic after analyzing 891 publications from 2000 to 2023 [12]. M. Akhtaruzzaman and other scholars, based on an analysis of 22,820 company observations across 13 countries, found a positive relationship between awareness of climate risks and the level of environmental innovation [13].

A. Ozkan, H. Temiz, and Y. Yildiz [14], as well as Y. Tang, D. Gao, X. Zhou [15], and D. Duan [16], demonstrated that the disclosure of such information positively correlates with ESG performance indicators and companies' financial results — particularly in sectors characterized by a high degree of digitalization and access to sustainable finance.

Russian researchers propose various classifications of environmental risks. For instance, A.V. Norko [17] and E.A. Alekseeva [18] categorize them according to: type of impact (direct/indirect), source (natural/anthropogenic), scale (local/regional/global), duration (acute/chronic), and manageability (controllable/uncontrollable). E.A. Alekseeva, in particular, highlights the need to distinguish between environmental risks that directly affect ecological safety and their economic consequences for businesses. L.A. Mochalova [19] identifies risks arising from technological, logistical, and natural–climatic factors as being particularly relevant to industrial enterprises.

The distinction between environmental and climate factors has not only conceptual but also practical significance for the development of corporate strategies. Environmental risks encompass a broad range of threats associated with the disruption of natural ecosystems, environmental pollution, resource degradation, and biodiversity loss. These

[7] URL: https://documents1.worldbank.org/curated/en/280911488968799581/pdf/113237-WP-WhoCaresWins-2004.pdf

[8] URL: https://members.iacpm.org/common/Uploaded%20files/Samples/Downloadable%20content/Research_ESG%20and%20Climate%20Risk/IACPM-Research-ESG-Climate-Risk-Management-Frameworks-White-Paper.pdf

[9] URL: https://assets.kpmg.com/content/dam/kpmg/gr/pdf/2025/01/gr-kpmg-esg-risk-survey-for-banks.pdf

risks are typically local or regional in nature and can be directly linked to a company's production activities.

Climate risks, by contrast, are associated with global processes of climate change. Unlike environmental risks, they require long-term strategic planning, scenario analysis, and often cannot be mitigated through local measures alone [2, 12, 13].

Thus, environmental and climate factors should be viewed as intersecting but not identical categories: climate risks represent a specific subset of environmental risks, characterized by a high degree of uncertainty, cross-border impact, and long-term temporal horizon [12, 14, 16].

In international practice, the classification proposed by the Task Force on Climate-related Financial Disclosures (TCFD[10]) has gained the widest acceptance. The IFRS S 2[11] standard, adopted in 2023, formalized this approach by requiring disclosure of both climate-related risks and associated opportunities in corporate reporting. Accordingly, the following categories are distinguished:

- physical risks, resulting from acute events (e.g., hurricanes, floods) and chronic changes (e.g., global warming, sea-level rise);
- transition risks, arising from the shift toward a low-carbon economy (including regulatory, market, technological, and reputational factors).

The classification developed by the Bank of Russia is largely consistent with the TCFD.[12] framework. However, while about 80% of Russian companies disclose some form of climate-related information, only 20% align their reporting with the TCFD and IFRS S 2[13] standards.

Based on the above, the following research questions were formulated:

1. How are climate risks addressed and incorporated in the strategic documents of companies within the aquaculture sector?

2. What types of climate risks are most relevant to aquaculture companies, and how do they correspond to the international TCFD classification?

3. What mitigation measures can be applied to reduce the impact of climate risks for Russian companies in this sector?

MATERIALS AND METHODS

For the analysis, PJSC "INARCTIKA" (hereinafter — Inarctica) was selected as the focus company — the largest aquaculture producer in Russia and the only publicly listed Russian corporation in this sector[14] — along with its direct Norwegian competitors: Mowi ASA (Mowi), Grieg Seafood, and Lerøy Seafood Group (Lerøy). The key selection criterion was geographical comparability: all companies operate in the Barents Sea region under Arctic or sub-Arctic climatic conditions, ensuring the relevance of both climate-related risks and operational opportunities. The Norwegian companies are among the top 40 publicly listed firms in Norway by revenue.

The main data sources included:

- Annual and non-financial reports (including sustainability and climate reports in line with TCFD recommendations);
- ESG assessments from international agencies (CDP, Sustainalytics);
- Publications on official corporate websites;
- Industry analytical reviews;
- ESG ratings from Russian agencies (NRA, RAEX) for the analysis of Inarctica's case.

Climate risk assessment was based on the TCFD classification, which distinguishes between physical and transition risks. Additionally, content analysis of corporate strategies was conducted to identify climate-related goals, the degree of specificity, and the presence of quantitative targets.

The comparison criteria included both financial and non-financial indicators, such as: availability of climate and ESG strategies; participation in sustainability ratings; level of information disclosure; identified and reported climate-related risks.

[10] URL: https://www.fsb-tcfd.org/publications/

[11] URL: https://www.ifrs.org/content/dam/ifrs/publications/pdf-standards-issb/english/2023/issued/part-a/issb-2023-a-ifrs-s2-climate-related-disclosures.pdf?bypass=on

[12] URL: https://www.cbr.ru/Crosscut/LawActs/File/7666

[13] URL: https://b1.ru/local/assets/surveys/b1-overview-of-russian-companies-ifrs-s2-climate-related-reporting.pdf

[14] The company's shares are included in the first level of the Moscow Exchange listing; in 2010, the IPO was held, and in 2023– SPO.

Table 1

Comparative Analysis of ESG Criteria in Company Strategies for the Selected Sample

Company Name	Availability of a Sustainability / ESG Committee in the Board of Directors	Availability of an ESG or Sustainability Department	Presence in International/ National ESG Ratings	Availability of TCFD for 2023
Mowi	Sustainability Committee (hereinafter SC) as part of the Board of Directors	There is a Director for SC issues/ ESG topics are included in the "Leading the Blue Revolution" strategy and implemented in such areas as feed, farming, and processing	Sustainalytics: Medium Risk Coller FAIRR Protein Producer Index: 1st place in the world	No (only for 2022)
Lerøy	–	An ESG and Quality department operates	Sustainalytics: Medium Risk Coller FAIRR: 2nd place in the world (2023)	Yes
Grieg Seafood	–	–	Sustainalytics: High Risk Coller FAIRR: 3rd place in the world (2023)	Yes
Inarctica	Sustainability Committee	Environmental Service, Scientific Research Department	RAEX ESG- rating: ranked 62nd out of 144 companies1 ESG-Rating of Russian Industrial Sector Companies, version 2.0, NRA — 0,500 points, 4th group (developing ESG maturity level)	–

Source: compiled by the authors.

Note: * URL: https://raex-rr.com/news/press-reliz/esg_ranking_final_2024/

RESULTS

Both Inarctica and its Norwegian competitors have developed sustainability or climate strategies. All Norwegian companies conduct greenhouse gas (GHG) emissions calculations across Scopes 1–3 and hold a CDP score of A-, which indicates the implementation of advanced solutions aimed at achieving carbon neutrality and the setting of science-based targets (SBTi) (see *Table 1*).

As shown in *Table 1*, Mowi holds a leading position among the reviewed aquaculture companies worldwide in terms of integrating climate-related ESG aspects into strategic management. The company implements a range of policies, including those on climate change and energy use, incorporating relevant initiatives into its "Leading the Blue Revolution" strategy. Its key priorities include reducing greenhouse gas emissions, improving resource-use efficiency, and promoting environmentally responsible production practices.

The corporate structure features a Sustainability Committee within the Board of Directors and a Director of Sustainability. According to Sustainalytics, Mowi is classified as a medium-risk company, while the Coller FAIRR Protein Producer Index ranks it first globally among animal-protein producers. In the aquaculture sector, its financial performance is also the strongest worldwide: in 2023, the company reported revenues of USD 6.03 billion and net profit of USD 0.82 billion.[15]

Lerøy, ranked second among the analyzed companies, also pursues climate and energy policies.[16] Although its Board of Directors does not include a dedicated ESG committee, the company maintains a specialized ESG and Quality Department. Its ESG assessment by Sustainalytics is similar to that of Mowi, and in the Coller FAIRR Index it ranks second globally. Financially, Lerøy closed 2024 with revenues of USD 2.87 billion and a profit of USD 0.26 billion.

[15] URL: https://companiesmarketcap.com/norway/most-profitable-companies-in-norway/?page=1

[16] URL: https://www.leroyseafood.com/en/sustainability/sustainability-library-2023/policies/policy-climate/.

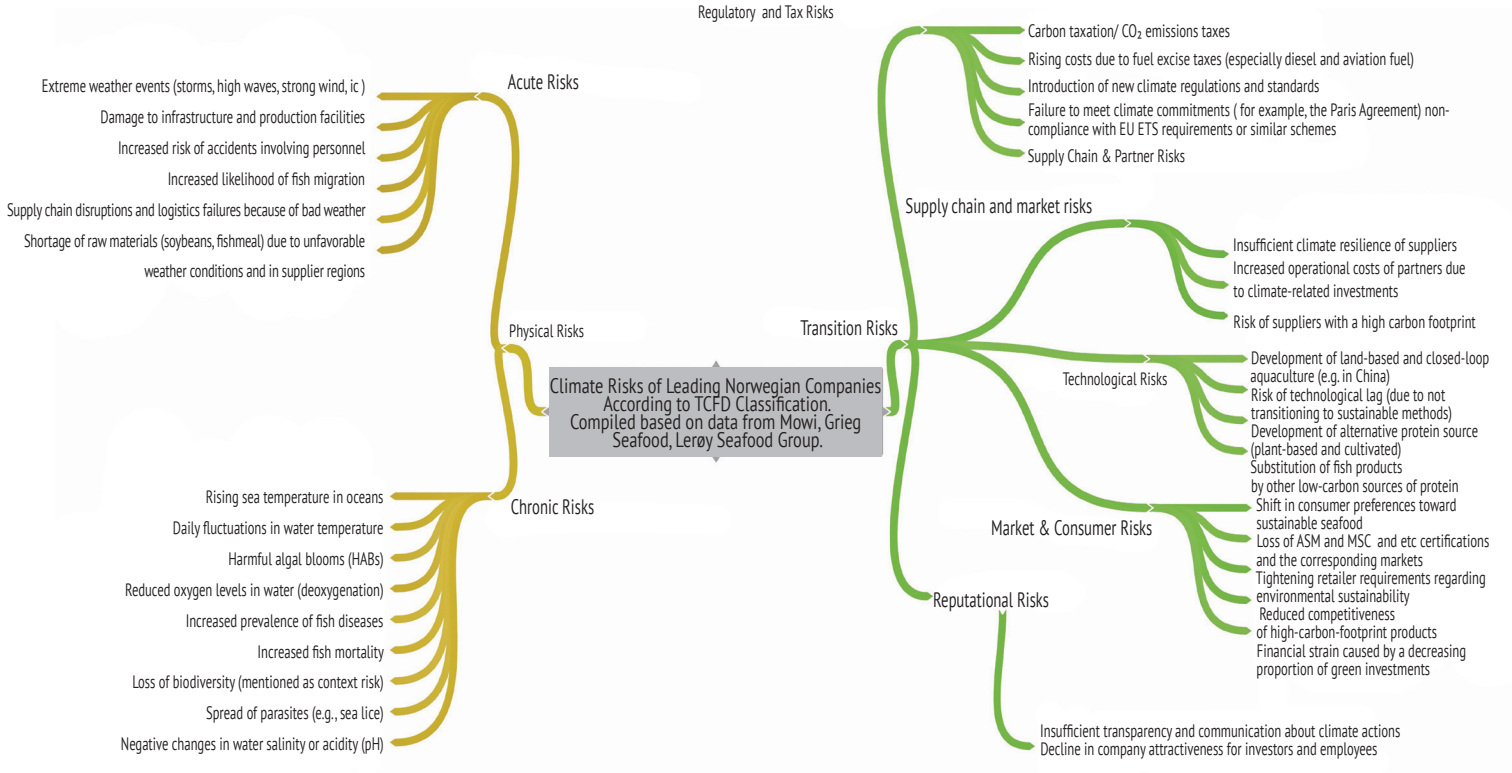

Fig. **Climate Risks of Leading Norwegian Companies under TCFD Classification up to 2050**

Source: compiled by the authors.

Grieg Seafood lags significantly behind the first two companies in terms of production volume (72 thousand tons in 2023,[17] compared with 484 thousand tons for Mowi[18]) and ended 2024 with a negative financial result (a loss of USD 0.24 billion). The company has neither a dedicated ESG or sustainability department nor a board-level committee, and no publicly available strategic document on climate change. Its ESG ratings are notably lower, indicating higher exposure to sustainability-related risks.

Inarctica trails far behind its Norwegian competitors in both production and financial scale (28.2 thousand tons of output, revenues of USD 0.31 billion, and net profit of USD 0.08 billion[19]). Although it does not disclose Scope 3 emissions or climate-related risks in line with TCFD recommendations, it has established a relatively well-developed sustainability governance system: the Board of Directors includes a Sustainability Committee, and the company's operational structure comprises an Environmental Department and a Research and Development Department.

While Inarctica appears in national ESG rankings, the results presented in *Table 1* indicate a low level of integration of ESG principles into corporate management.

The climate risks specific to aquaculture companies operating in the Barents Sea region are presented in the following figure.

As shown in the *Figure*, acute risks include extreme weather events, infrastructure degradation, production incidents, logistical disruptions, and raw material shortages. Chronic risks refer to long-term changes in the marine environment, while transition risks encompass regulatory, technological, market, and reputational aspects associated with the shift toward a low-carbon economy.

[17] URL: https://www.inderes.dk/en/releases/grieg-seafood-reports-q4-and-preliminary-results-for-2024-restructures-and-refinances-to-refocus-on-profitable-growth-in-norway

[18] URL: https://weareaquaculture.com/news/aquaculture/mowi-reports-all-time-high-harvest-and-eur-136m-operational-revenue

[19] URL: https://inarctica.com/investors/reports-and-results/

Table 2

Climate Risks and Mitigation Measures for Inarctica

Risk Category	Description	Potential Impact	Mitigation/Adaptation Measures
Physical Risks			
Rising water temperature	Warming of Arctic waters increases the prevalence of sea lice and bacterial infections, causing stress to fish populations	Slower fish growth, higher mortality, increased costs for pharmaceuticals	Breeding heat-tolerant fish, implementing deep-water cage technology
Extreme weather events	Climate change increases the frequency of storms and strong winds; complex ice conditions may occur	Damage to cage farm infrastructure, fish escapes — temporary suspension of aquaculture operations	Investment in reinforced, storm-resistant equipment and coastal infrastructure
Oxygen depletion in bays (operational areas)	Higher temperatures and eutrophication reduce oxygen levels, especially in shallow bays	Increased fish mortality	Monitoring oxygen levels, optimizing stocking density
Harmful algal blooms (HABs)	Warmer waters and nutrient influx promote growth of toxic algae, leading to mass fish die-offs	Fish losses due to disease, quality reduction, delayed harvesting; increased monitoring costs	Implementation of monitoring and early warning systems
Spread of diseases and parasites	Rising water temperatures extend parasite lifecycles (e.g., sea lice), increasing fish infestations	Higher treatment costs, antibiotic resistance, reduced fish quality	Use of non-chemical parasite control methods; employment of cleaner fish, e.g., Cyclopterus lumpus, that feed on sea lice
Coastal erosion and flooding	Sea level rise and storm surges threaten coastal facilities	Damage to processing plants and storage facilities	Build infrastructure on elevated sites; improve flood protection measures
Supply chain disruption	Climate-driven transport issues (road washouts, storms) affect feed delivery and product distribution	Operational delays, increased transport costs	Develop local feed production; ensure alternative transport routes
Transition Risks			
Regulatory pressure	Stricter environmental regulations and changing consumer preferences toward climate-safe products	Higher compliance costs; loss of market share if sustainability standards are not met	Adopt sustainability certifications (Aquaculture Stewardship Council — ASC, Marine Stewardship Council — MSC, Best Aquaculture Practices — BAP); invest in low-carbon feed
Market demand and NGO pressure against antibiotic use	Public movement for healthy living, eco-friendly products, and against antibiotics in fish farming	Increased feed and operational costs; potential ecological imbalance in water bodies, ecosystems, and microbiomes	Breed disease-resistant fish

Source: compiled by the authors.

The analysis revealed that in the case of Inarctica, climate risk management remains insufficiently developed. In the company's 2023–2024 reports, natural and climatic factors are addressed only as background context, without a formal classification or quantitative assessment in accordance with international standards such as TCFD and CDP. Furthermore, there is no description of managerial approaches to climate risk: they are neither classified nor linked to the KPI system, and have not been

verified under international methodologies. This indicates an institutional gap between the recognition of climate impacts and their formalization within corporate governance, which reduces transparency and limits access to sustainable financing.

Accordingly, drawing on the practices of Norwegian companies and other scholarly and applied sources — including the Register of Hazardous and Adverse Hydrometeorological Phenomena and Their Criteria for the Murmansk Region,[20] the book Climatic Myths of the Kola Peninsula (published by PJSC Norilsk Nickel[21]), and Development Scenarios for the Murmansk Region under Global Uncertainties and Climate Change [20] — the authors have proposed a qualitative assessment of key climate risks relevant to Inarctica. A quantitative assessment, involving risk ranking and scenario analysis, is identified as a potential next stage of the research (see *Table 2*).

The content of *Table 2* serves as the foundation for developing the company's climate strategy. Implementing a climate risk assessment will allow the company to reduce risks, design and implement mitigation measures, and increase compliance with international sustainable development standards.

DISCUSSION OF RESULTS AND RECOMMENDATIONS

The analysis shows that climate and environmental risks in the aquaculture sector are becoming increasingly systemic. However, the effectiveness of risk response depends not only on natural and climatic vulnerability but also on the level of ESG maturity within companies. Where climate impacts are formalized in strategies, metrics, and top management incentive systems (as in Mowi and Lerøy), risk management becomes an integral part of corporate resilience. In companies where this is absent (such as Inarktica), both natural and managerial risks remain significant.

Analysis of public reporting indicates that, despite the presence of environmental initiatives (such as reducing antibiotic use, environmental certification, and developing a research department), climate aspects in the documents of the Russian company are fragmented and unstructured. The lack of classification of climate risks, as well as the absence of clearly defined climate targets, reduces the company's ranking in ESG ratings, limits comparability with international competitors, and constrains its potential to access sustainable financing.

In this context, several directions can be proposed to develop Inarktica's climate and ESG strategy, taking into account the successful practices of Norwegian peers.

First, it is advisable to formulate clear, quantitatively measurable, and scientifically grounded climate targets. These may include reducing greenhouse gas emissions across all scopes (Scope 1–3) and lowering water consumption.

Second, ensuring transparency of environmental and climate policies through regular reporting according to international non-financial disclosure standards, such as TCFD (IFRS S 2) and CDP. Such openness will help build trust among investors, partners, and regulators, strengthen the company's position in ESG rankings, and facilitate access to sustainable financing mechanisms, including green bonds and adaptation-related financial instruments.

Third, biotechnological modernization of production can be a promising direction, involving the use of seaweed and mussels as alternative feed sources, as well as the development of solutions in bioenergy and sustainable protein. These innovations, already applied by international competitors, not only reduce the carbon footprint but also create opportunities for product and technological diversification.

Additionally, there is significant potential to enhance resilience through the implementation of circular economy principles, including resource reuse, waste reduction, electrification of logistics, and environmentally oriented design of packaging and feed. This approach is increasingly relevant amid growing pressure on global natural resources and the transition to a circular production model.

CONCLUSION

The comparative analysis of practices between Russian and Norwegian companies revealed significant differences in the degree of development

[20] URL: https://murmashi51.ru/city/bezopasnost-municipalnogo-obrazovaniya/informaciya-po-gochs-i-pb/429655/

[21] URL: https://www.kolagmk.ru/upload/disclosure/Climate_myths.pdf

of the climate agenda and in its integration into corporate strategies and reporting.

The most advanced practices were demonstrated by Norwegian companies, which integrate climate factors into strategic management and risk management systems. Their experience confirms that comprehensive disclosure of climate risks in accordance with TCFD recommendations, along with clearly defined quantitative climate targets and adaptation programs, enhances corporate resilience and competitiveness.

At the same time, the case analysis of the Russian company Inarktica revealed limited institutional development of climate risk management, a lack of systematic disclosure, and insufficient integration of climate aspects into management practices.

Developing a comprehensive climate strategy focused on transparency, adaptation, and innovation will not only help minimize potential losses from climate-related risks but also leverage the ESG agenda to enhance investment attractiveness.

For aquaculture companies operating in environmentally sensitive regions, such as the Arctic, this should become a strategic management priority.

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Assessment of the Economic Security of Carbon-Intensive Industries in the Oil and Gas Sector of the Economy

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ABSTRACT

The relevance of the article is related to the analysis of the business model of the leading carbon-intensive industries included in the holding of the petrochemical market. **The objective** of the study to improve the value formation model for petrochemical production. **The results** of evaluation demonstrate the obsolescence of the profit generation model, which confirms the statement that it is necessary to improve value creation models during the transition to a new level of technological development and a change in the economic development model. In addition, shifting consumer interests dictate the need to transform familiar business processes in order to create value for consumers and suppliers. **Research results**. According to the authors, in the context of the transition to carbon neutrality, the relevant models that form value are models of responsible consumption and transfer of responsibility based on the principles of K. Christensen. The uniqueness of both models lies in the formation of profits due to reproducible raw materials (in fact, recyclable production waste) and the sale of spent or released carbon units, as well as in a new way of interaction between production participants by registering on a technological platform (ESG platform). The authors also note that the area of value creation is changing (decreasing), that is, the area of business competence will be determined by the principles of sustainable development. It should be noted that the level of economic security of petrochemical industries in the new conditions of transition to carbon neutrality directly depends on the value creation model.

Keywords: petrochemical industries; ESG projects; sustainable development; oil and gas sector of the economy; value chain; circular business models; low-carbon regulation; platform solutions; economic security

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INTRODUCTION

The key task of any enterprise is to generate a profit model, each of which soon enough becomes obsolete due to the rate of change in technological solutions and consumer preferences, which also determines the development of approaches in this area. The new profit model should create value not only for owners and shareholders, but also for society, suppliers and related businesses. These are the principles laid down in the concept of sustainable development. The post-industrial economy is in conformity with the principles of sustainable development, which determines the transformation of existing profit models. In addition, enterprises have a growing risk of losing the market if they never change their approaches to forming business value, so it is necessary to assess the economic security of those entities that form the major bulk of state revenues. Since the principles of sustainable development mainly mirror the activities of carbon-intensive industries, the area of the given research interests is the petrochemical sub-sector of the economy, which contributes to the formation of the greatest added value in the national oil and gas sector. The authors analysed the activity industries in the West Siberian and Volga clusters of the petrochemical market.

Thus, the objective of the article is to enhance the profit generation model of petrochemical production based on the assessment of the economic security of existing approaches to value creation. For this aim, it is necessary to solve the following tasks:

1. Perform an analysis of the data of the financial model of petrochemical production because of methodological approaches that allow determining the stability, inflow or outflow of values;

2. Improve the business models of petrochemical production through platform solutions for obtaining value for society and suppliers of related industries.

The hypothesis of the research is that when moving to a next level of economic development, it is necessary to have value formation models transformed. Despite the fact that sustainable development presupposes renewable energy sources replaced traditional sources [1], some of the countries have not managed to reach their distribution at a large scale (*Fig. 1*). However, China's experience is one of the most interesting for Russia related to the capture technologies of CO_2 and obtaining alternative energy [2]. Moreover, the forecast for the domestic carbon regulation market indicates the application perspectives of this area (*Fig. 2*), which will contribute to the development of new types of business [3,4], and thus, the formation of completely new value models.

It is worth pointing out that a business model that contributes to the growth of value for one enterprise will not be effective for another. Since the unified approach does not exist. Besides, technological progress leads to a swift decline of relevance of existing models, which implies inevitable transformation of these models during the transition to a new (the 6th) technological paradigm.

The basis for the given research included theoretical approaches that determine the business model as a conceptual framework for business value. This was reflected in the works of Linder J., Cantrall S., Osterwalder A., Chesborough G. It should be pointed out that the system of creating value for petrochemical enterprises lays the foundation for generating profits in the oil and gas sector of the economy. Many scientists

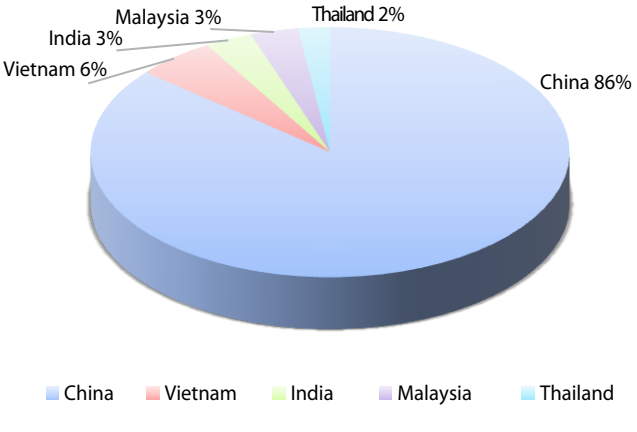

Fig. 1. **Production of renewable energy (solar modules), %**

Source: compiled by the authors.

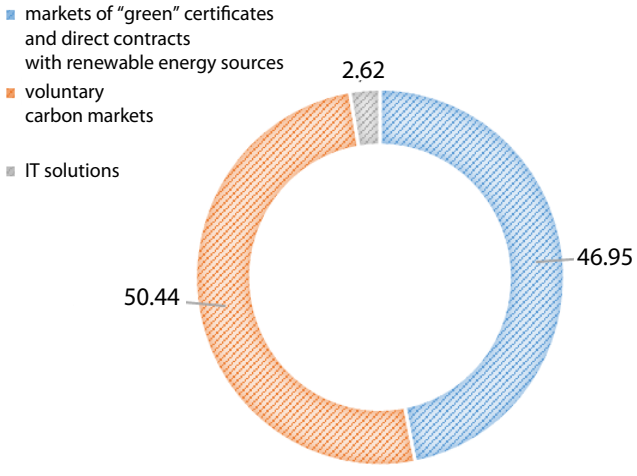

Fig. 2. **Forecast of the Carbon Market Volume in Russia in 2030, %**

Source: compiled by the authors.

dedicated their research work related to business modeling. Thus, P. Drucker described business as a set of proposals, P. Timmers characterised the model of forming a value proposition as a new way of making a profit, J. Magretta called the business model the architecture and transformation of the processes of creating a product, and K. Christensen presented the business model as a profit formula obtained through basic resources [5, 6, 7].

The principles of reduction of the carbon intensity in production were analysed by V.S. Anshin, E. Barbier, J. Forrester, V.I. Vernadsky and some other scientists, in view of new processes of generating added value in the post-industrial era. A. Smith, D. Riccardo, K. Marx and some other scientists provided the methodological foundations of value creation with basic approaches to defining the value system. M. Porter, G. Gereffi, M.V. Mayer, S. Shi, V.N. Tatishchev, M.V. Lomonosov etc. described ideas regarding the formation of value at the beginning and at the end of a practice-oriented chain of product creation. M. Levy defined the "value equation" and considered the formation of a business model in conjunction with the strategy of an enterprise. A. Pulik and A. Slivotsky analysed the indicators of the "strength" for a business model and the influence of intellectual capital on its effectiveness [8–11].

METHODOLOGY OF THE STUDY

The following indicators were evaluated to examine the economic security of the given business model of petrochemical production:

1. Return on invested capital (ROIC) is an assessment of the company's profitability and its potential to create value in relation to capital:

$$ROIC = \frac{NOPAT}{E + LTD}, \quad (1)$$

where *NOPAT* — Net Operating Profit After Tax;
E — equity;
LTD — long-term debt.

2. Weighted Average Cost of Capital (WACC) is the average interest rate for all sources of financing of the company:

$$WACC = \frac{CE}{TCC} \times PE + \frac{BC}{CBC} \times TVC, \quad (2)$$

where *CE* — cost of equity;
TCC — total cost of capital;
PE — price of equity;
BC — amount of borrowed capital;
CBC — cost of borrowed capital;
TVC — total value of capital.

The difference between ROIC and WACC determines the efficiency of business activity: a negative value indicates the lack of the generated value of the business model for stakeholders.

3. According to A. Slivotsky, the market value to revenue ratio reflects the strength of the business model. Within the period of value inflow, it has a greater value than 2.0. Meanwhile during the period of stability, the value ranges from 0.8 to 2.0. During the period of value outflow, the value drops below 0.8, which means the inability of the business to generate profit [12]:

$$\text{"The strength" of a business model} = \frac{\left(\frac{Market\ value}{Revenue}\right)_{t+1}}{\left(\frac{Market\ value}{Revenue}\right)_{t}}, \quad (3)$$

Economic added value (EVA) is the return on investment in business. A negative value of this indicator means a decrease in the value of the business for the owner:

$$EVA = Invested\ capital \times (ROIC - WACC). \quad (4)$$

Intellectual value added coefficient according to the Ante Pulik method (VAIC) indicates the use of physical capital at the expense of intellectual:

$$VAIC = CEE + HCE + SCE, \quad (5)$$

where: *CEE* — added value of physical capital;
HCE — added value of human capital;
SCE — added value of structural capital.

At the same time, the efficiency of value creation at the expense of the added value of physical capital depends on the invested resources; due to the added value of human capital generated from the intellectual abilities of people; due to the added value of structural capital obtained from the results of human activity.

RESEARCH RESULTS

To carry out the research, the authors processed a bulk of data set from the financial statements of the petrochemical production facilities of PJSC SIBUR Holding (*Table 1*). The reason for the choice of this object was determined by the fact, that it included key players in the Russian petrochemical market, divided into six clusters. Thus, the study of the general statements defines a concept of the business model of all enterprises included in the holding. The authors carried out the start-to-finish analysis of the West Siberian and Volga Region petrochemical clusters. Concurrently, the Herfindahl-Hirschman index reveals monopolisation and high barriers to entry into the petrochemical market; its values are 4642.1 for 2018 for the West Siberian oil-and-gas play and 7957.8 for the Volga Region oil-and-gas play. The main scientific interest stemmed from the point of view, how large enterprises respond to changes in the economic development model.

The analysis of the data for seven periods indicates the following (*Table 2*): starting from the year of 2022, the cost of capital (WACC) grew due of the fact that the price of equity and debt capital increased (interest on loans became higher). At the same time, the return on invested capital (ROIC), which reflects the value of suppliers, shareholders and investors, is decreasing. This represents the inefficiency of the existing business model.

The change in economic added value (*Fig. 3*) indicates a decrease in the value of the business for the owners, which in turn is the evidence of an increase in the cost of capital. The cost of borrowed capital increased due to interest on loans (17.21 per cent for Ruble loans, 4.13 per cent for US Dollar loans in the year of 2022), and equity capital increased as a result of dividend payments to shareholders, which have increased six-fold since the year of 2017 (*Fig. 4*).

The line in the figure indicates that the existing business model is becoming obsolete.

Figure 5 illustrates that since the year of 2021, the "strength" of the market potential of the business model has been sharply declining, and in the year of 2023 the indicator value was 0.476, which demonstrates an outflow of value, which means, that the business can no longer generate profit.

The figures in *Table 3* indicate that the intellectual capital of PJSC SIBUR Holding demonstrates a growing tendency, meanwhile wage costs are decreasing and the use of human capital is increasing, consequently, the added value of intellectual capital increases. Since the data for the year 2021 are partially presented in the given article, it was impossible to calculate some indicators for this period with more precision, however, this does not make any visible change of the indicated trend.

DISCUSSION OF RESULTS

The analysis revealed that since the year of 2022, the existing model has ceased to be relevant, another words, it has lost the ability to bring value to owners, shareholders and other stakeholders. It is worth pointing out, that intellectual capital, on the contrary, has shown a tendency to grow. This demonstrates the efficiency of using the structural elements of the indicator, in particular, the human capital, which, however, did not allow increasing the value of the business model. Then K. Christensen's model has become the basis for the new approaches, as it involves the creation of

Table 1

The Initial Data for Calculating the Performance Indicators of the Business Model of PJSC SIBUR Holding

Indicator	Time period						
	1	2	3	4	5	6	7
Equity (thousand Rubles)	347121460	429833084	502182577	509265038	869375233	900263501	881263643
Long-term debt (thousand Rubles)	186329298	158172900	185299112	246655682	410108508	532699145	519327529
EBIT (thousand Rubles)	331679801	440876942	413116940	379263421	481874916	858835357	935965128
Net assets (thousand Rubles)	347122927	429839308	502188708	509271078	869381184	900269366	881269431
Revenue (thousand Rubles)	373705693	486061865	462950229	428705659	517008164	934504822	1031571277
Cost of sales (thousand Rubles)	244794465	307458323	316580546	311622196	302408695	622377949	698193738
Wages (thousand Rubles)	280 289	326 464	346 934	278 078	–	312 221	249 700
Equity (thousand Rubles)	347121460	429833084	502182577	509265038	869375233	900263501	881263643
Long-term debt (thousand Rubles)	186329298	158172900	185299112	246655682	410108508	532699145	519327529

Source: compiled by the authors according to the financial statements of PJSC SIBUR Holding for the years of 2017–2023.

Table 2

Analysis of the Effectiveness of the Business Model of PJSC SIBUR Holding

Indicator	Time period						
	1	2	3	4	5	6	7
IC (investment capital. thousand Rubles)	533 450 758	588 005 984	687 481 689	755 920 720	1 279 483 741	143 2962 646	1 400 591 172
NOPAT (after-tax profit. thousand Rubles)	94132956	108439462	111910673	37123687	190980485	185816576	90744230
ROIC, %	17.646	18.442	16.278	4.911	14.926	12.9679	6.479
WACC, %	5.578	5.121	6.191	1.3848	3.814	14.705	11.609
Revenue growth	1.034	1.301	0.952	0.926	1.206	1.808	1.104
Economic value added (EVA. thousand Rubles)	6 437 749 473	7 778 777 386	6 934 876 630	2 665 804 439	14 218 560 896	–2 489 839 432	–7 184 407 786
ROIC-WACC	12.068	13.320	10.087	3.526	11.113	-1.738	-5.129

Source: compiled by the authors according to the financial statements of PJSC SIBUR Holding for the years of 2017–2023.

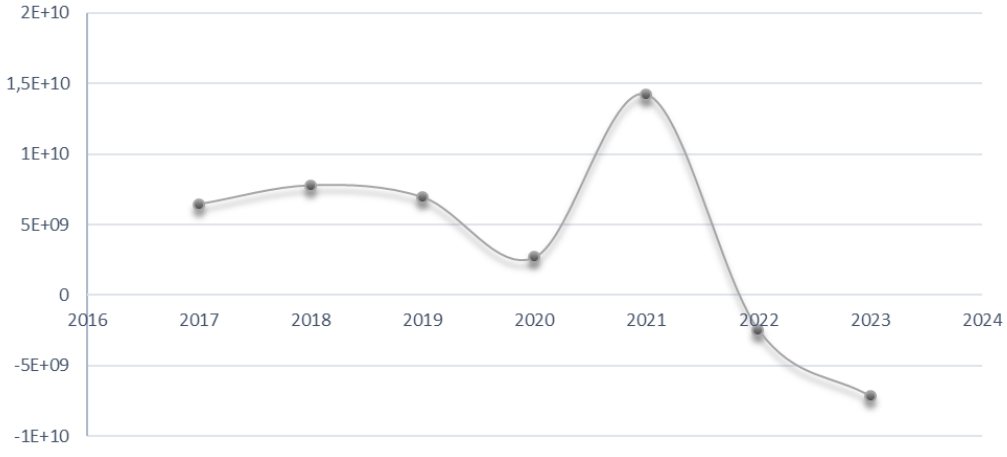

Fig. 3. **Economic Value Added (EVA) of PJSC SIBUR Holding (2016–2024)**

Source: compiled by the authors.

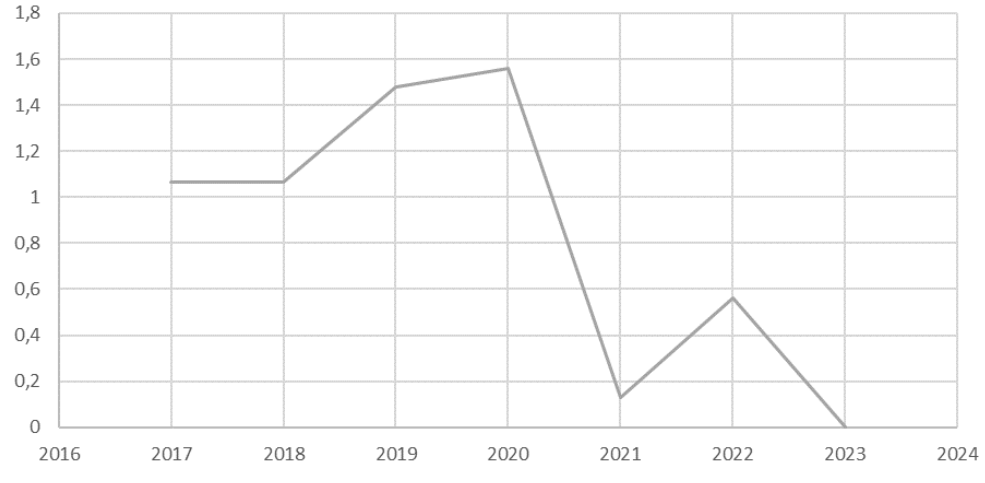

Fig. 4. **Trends in the Value Generation Process of PJSC SIBUR Holding**

Source: compiled by the authors.

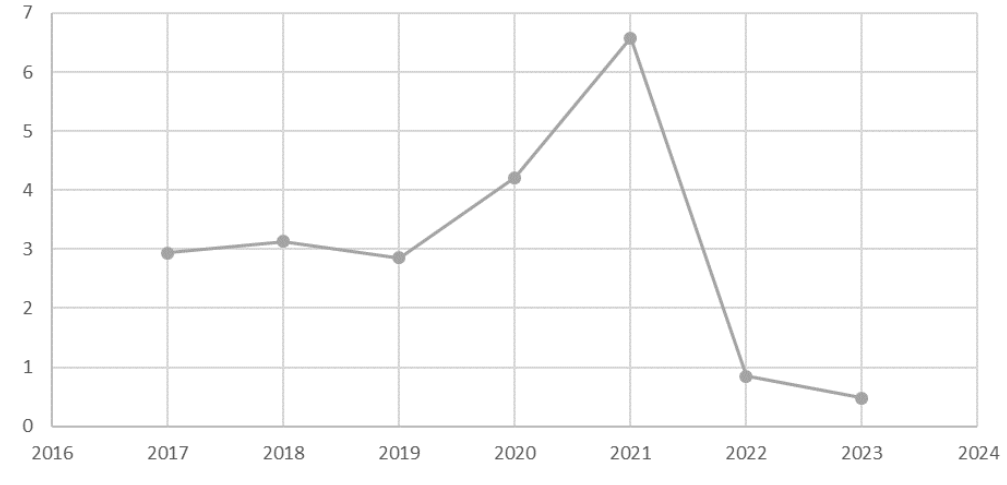

Fig. 5. **The Market Potential of the SIBUR Holding PJSC Business Model According to Adrian Slivotsky**

Source: compiled by the authors.

Table 3

Intellectual Capital of the SIBUR Holding PJSC

Indicator	Time period						
	1	2	3	4	5	6	7
VAIC	378.562	488.341	378.728	314.369	-	1547.140	2196.507
CEE	0.198	0.270	0.190	0.115	-	0.337	0.391
HCE	377.366	487.073	377.539	313.258	-	1545.804	2195.116
SCE	0.997	0.998	0.997	0.997	-	0.999	0.999

Source: compiled by the authors according to the financial statements of PJSC SIBUR Holding for the period of 2017–2023.

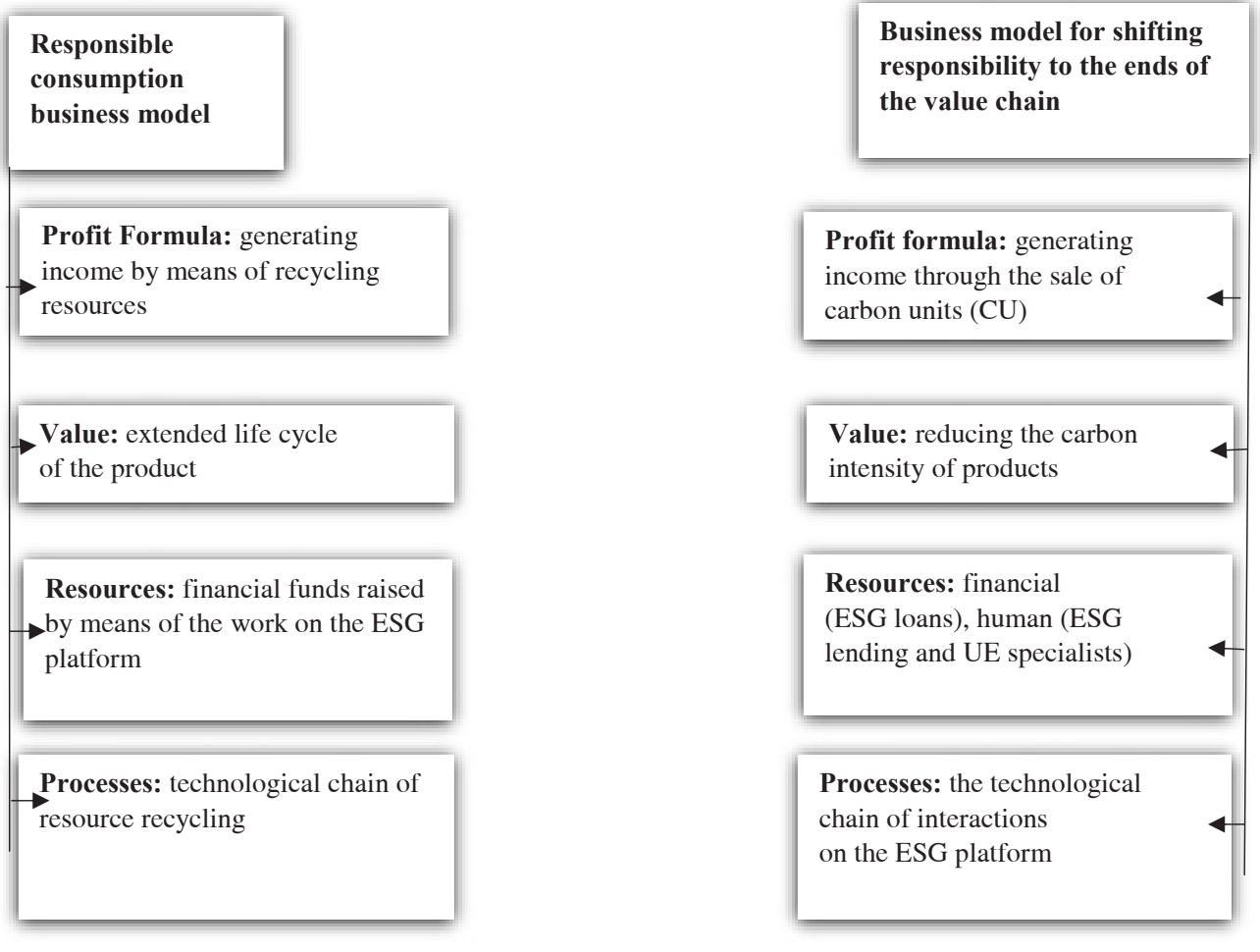

Fig. 6. **Architecture of Business Models for Profit Formation of Petrochemical Industries in the Context of Transition to Carbon Neutrality**

Source: compiled by the authors.

value by means of generating resources and key activities (*Fig. 6*). From our point of view, the most important element is the "profit formula", which takes into account the values of suppliers and consumers. The "profit formula" contributes to an increase in life cycle of the product, which is advisable to start from the "input level" of the value chain, taking into account the prin-

ciples of sustainable development. Furthermore, actions are possible within the framework of the manufacturer's value chain: the introduction of technologies into their business processes to capture CO_2, the development of ESG projects, as well as the use of funds raised as part of the working process on the ESG platform.

The proposed model is based on generating profits by means of resource recycling, increasing the life cycle of the product, obtaining funds on the ESG platform, as well as using an innovation technology to enable interaction between the supplier and the consumer. However, there arises a problem, not all production facilities are ready for this, but they must meet market requirements and create value not only for the owners, but also for raw material suppliers and associated manufacturers. The authors envisage a proper solution in transferring responsibility: namely, production facilities that have not met the requirements for the reduction limit of CO_2 can purchase carbon units from the enterprises that generate the units. This model is in consistency with the principles of generating profits suggested by Christensen, however, the model provides for not only the development of technologies that help reduce of missions CO_2, but also new forms of interaction between supplier, producer and consumer through a technological (ESG) platform [13].

Thus, the transition to a new (post-industrial) economy is distinguished by a change in the profit generation model. Otherwise, enterprises will lose value for suppliers and consumers, as well as for shareholders and subsequently for owners, which will eventually lead to a decrease in their share in the market and withdrawal from the market. This situation also applies to the petrochemical sub-sector, as it became a key source of value creation in the oil and gas sector of the economy.

CONCLUSIONS AND RECOMMENDATIONS

The article analyses the economic security of the model capable to generate profit of petrochemical production facilities including the SIBUR Holding PJSC group of companies, which demonstrates an outflow of value since the year of 2022. This occurs as a result of the excess of the weighted mean cost of capital over its profitability, which indicates a decrease in value for the supplier. Besides, since the year of 2022, the indicators of economic value added have negative numbers, which means a loss of business value for owners. The slowdown in the process of value generation also represent the evidence of the necessity to transform the existing model for petrochemical production facilities in the context of transition to a new technological mode, which confirms the hypothesis of the given research.

The authors have developed the architecture of business models for the transfer of responsibility and responsible consumption, based on the theoretical platform of K. Christensen, including a group of the following elements: profit formula, value proposition, resources, processes. Besides, the authors have proposed new means of generating profit (income from the sales of carbon units) and creating value (by increasing the life cycle of the product through the reproduction of raw materials), as well as integrating the links of suppliers-producers-consumers through an ESG platform.

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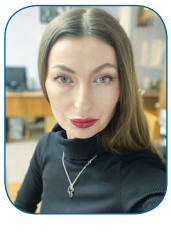

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Vera V. Plenkina — formulation of the research hypothesis, definition of the research problem.
Alexander A. Zubarev — development of the structure of the article.
Elena P. Kiselitsa — formulation of the article's relevance.

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ORIGINAL PAPER

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JEL J20

Working from Home in Russia: What Has Changed over Two Decades

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ABSTRACT

Relevance. The development of digital communication and connectivity technologies has significantly influenced labor markets in many countries. One of the consequences of technological progress in this area has been a shift in the geography of job performance, including an increase in the share of people working from home. The COVID-19 pandemic further contributed to the normalization of these processes, forcing a significant portion of workers to switch to remote employment. This article is dedicated to the study of this phenomenon in the Russian labor market from 2006 to 2023. **Methods.** Based on data from representative population surveys (RLMS-HSE), the scale of remote work in Russia is assessed, the composition of remote workers is described, and major changes in their profile are identified. Using logistic regression methods, the authors identify factors associated with a higher probability of this type of employment. **Findings.** The authors show that the key determinants are primarily characteristics of the workplace, the individual's education level, gender, and health status. The results of econometric regressions also indicate an increase in regular remote employment in Russia and a decrease in irregular remote work. **Practical significance.** The results suggest that the spread of remote work formats could help increase labor force participation and, at least partially, meet the demand for labor in the context of its shortage in Russia.

Keywords: work from home; remote employment; labor relations; COVID-19 pandemic; labor demand

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INTRODUCTION

One of the most notable transformations in global labor markets over the past few decades has been the spread of remote work, particularly home-based employment. In the previous century, this form of labor relationship remained outside the mainstream and was typically limited to small-scale artisanal work or to rare cases among creative professionals such as writers, musicians, and artists. Often, such work served merely as an additional source of income alongside a main occupation. Office employees only occasionally took part of their work home.

Technological innovation has been a major driver of the expansion of home-based employment. On the one hand, modern technologies enable effective remote communication, while the personal computer or work laptop has freed employees from being tied to a physical office. For example, in the United States, the share of remote workers was only 0.6% in 1975, but by 1985 — the year when personal computers first appeared on the market — it had already reached 4.8% [1]. On the other hand, the past decade has seen the emergence of numerous marketplaces, freelance platforms, and other digital ecosystems that allow workers and service providers to connect with clients regardless of their physical location. Thus, the rise of remote and platform-based employment has occurred in parallel with the increasing number of people working from home.

Nevertheless, working from home remained relatively rare for a long time, even when technological barriers to remote work had largely disappeared. A turning point came with the COVID-19 pandemic: in 2020, most developed and developing countries, including Russia, introduced various measures to slow the spread of the virus by restricting mobility and banning large gatherings. As a result, many employers were forced to switch their employees to remote work wherever their job functions made it possible.

In light of these developments, this study pursues the following objectives:

- to assess the scale and identify the main models of home-based employment in Russia from 2006 to 2023;
- to examine the changes in the socio-demographic profile of home-based workers over this period;
- to analyze the determinants influencing both the likelihood and the intensity of participation in this form of employment.

HOME-BASED EMPLOYMENT IN RUSSIA AND WORLDWIDE: STATISTICS AND RESEARCH OVERVIEW

This study follows the definitions proposed in the ILO Guidelines for Measuring Decent Work Indicators (2020[1]), which provide an international framework for collecting labor market statistics. According to these guidelines, work at home refers to any job or task performed by an individual from their home for at least one hour during the reference period. In addition, the ILO distinguishes several related, though not identical, concepts:

- Telework — work that does not necessarily take place at home but requires the use of electronic devices such as a computer, tablet, or phone (in contrast to home-based work, which may be performed without such devices). It should be noted that many empirical studies do not clearly separate these concepts and often treat them as equivalent.
- Home-based work — a narrower concept referring to work for which the home is the main place of employment.
- Unpaid domestic work — activities such as cleaning, cooking, household repairs, or caring for dependent family members, which, from the perspective of labor statistics, do not constitute employment.

In this paper, the terms "home-based employment" and "remote work" are used interchangeably.

The most comprehensive and consistent statistical data on home-based employment are available for European countries. Based on the EU Labour Force Survey, it is possible to trace how the prevalence of this form of work has changed in the European Union as a whole since 2002, and for individual

[1] URL: https://rtc-cea.cepal.org/sites/default/files/document/files/ILO-remote%20work.pdf

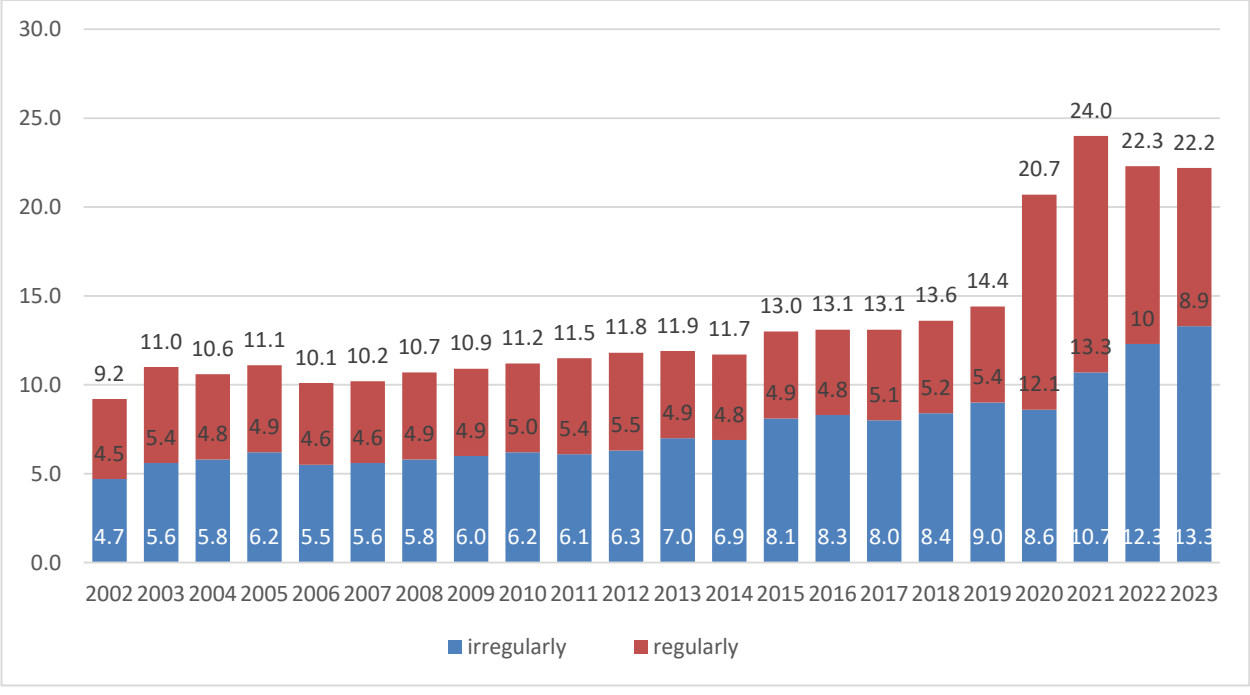

Fig. 1. **Extent of Work-from-Home Employment in the European Union (2002–2023), % of employees aged 15–64**

Source: compiled by the authors on: URL: https://ec.europa.eu/eurostat /

countries since even earlier periods. The European statistics distinguish between two categories:

1. Individuals who regularly worked from home in their main job (at least half of their working days during the past four weeks).

2. Individuals who worked from home occasionally or irregularly (less than half of their working days).

In the European Union, the share of people working from home has grown substantially since 2002. Until 2019, this growth was relatively gradual — from 9.2% at the beginning of the period to 14.4% by its end. In 2020, a sharp increase occurred, and by 2021 almost one in four employed persons worked from home. In 2022–2023, this figure slightly declined, stabilizing at around 22.2–22.3%.

At the same time, over the past two decades, the share of employees who regularly worked from home remained almost unchanged throughout the entire pre-pandemic period — around 5% of all wage earners. In contrast, the proportion of those working from home on an occasional basis increased from 4.7% in 2002 to 9.0% in 2019. As a result of the pandemic, the share of individuals working from home for more than half of their working time rose within a single year — from 5.4% to 12.1% — while by 2021 the structure began to revert to its pre-pandemic proportions.

It is important to note the significant cross-country variation in the prevalence of home-based work across the EU, both before and after the pandemic. The highest shares were observed in Central and Northern European countries (such as the Netherlands, Sweden, Switzerland, and Iceland), whereas in Southern and Eastern Europe this form of employment was almost non-existent (*Fig. 2*). The determinants of these differences may include both the economic structure — in which the share of jobs suitable for home-based work is considerably smaller than in most other European countries — and national characteristics of labor organization, including management traditions, workplace norms, and cultural attitudes [2]. Such heterogeneity calls for further investigation and, in our view, has not yet received adequate attention in the academic literature.

The spread of home-based employment in the United States has followed a trajectory broadly similar to that observed in the European Union. Its share

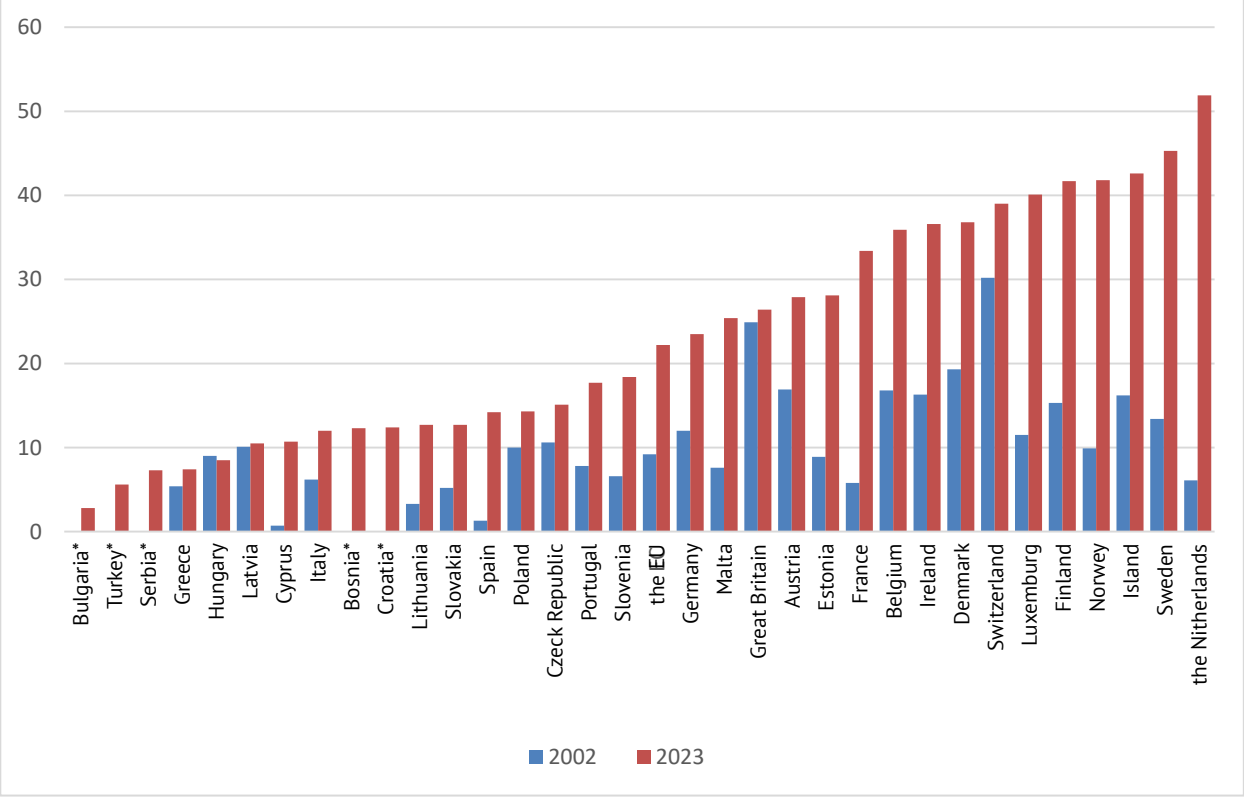

Fig. 2. **Extent of Work-from-Home Employment in EU Countries in 2002 and 2023 (% of employed aged 15–64)**

Source: compiled by the authors on: URL: https://ec.europa.eu/eurostat

Note: * There are no data for 2002.

increased from 0.4% in 1965 to 7.2% in 2019. During the pandemic, this indicator surged to 61.5%, which is substantially higher than in most European countries, and by 2023 it had stabilized at 28.1%, slightly above the European average [1].

Before 2020,[2] there were relatively few Russian or international studies addressing the phenomenon of home-based work. Most of these focused on the evolution of this form of employment as a result of technological progress in communication tools [3]; its impact on the work–life balance [4, 5]; and the assessment of the likelihood and productivity of such employment across different population groups [6, 7].

The number of academic publications on this topic increased manifold after the outbreak of the COVID-19 pandemic. The main research directions included analyzing who transitioned to remote work and how successfully this transition occurred following the introduction of various virus-containment measures [1, 2, 8], as well as examining worker satisfaction [9]. Several studies also reviewed pre-pandemic experiences of home-based work across countries [10, 11].

A number of articles have focused on the efficiency of working from home and its impact on labor productivity [12–14]. These studies employed experimental research designs in which two randomly assigned groups within the same organization were compared: the treatment group — employees transferred partially or fully to home-based work — and the control group, which continued to work in the office. The estimates obtained through this approach are robust and statistically reliable; however, they cannot be directly generalized to the entire economy.

[2] It should be noted that even before 2020, the topic of remote work was actively explored in management studies, albeit in a specific context — primarily from the perspective of personnel management in this work format. An analysis of these studies falls outside the scope of our article.

Evidence from many countries shows a broadly similar profile of individuals working from home. This type of employment was more prevalent among highly qualified workers, and consequently, among higher-income groups. Such workers were concentrated mainly in the fields of IT, telecommunications, education, business services, legal and accounting support, management consulting, and marketing. In professional terms, they were most often teachers, researchers, and IT specialists [10, 15]. In demographic terms, they tended to be younger individuals, while gender differences in home-based employment largely reflected occupational and sectoral heterogeneity in job structures [16].

Following the onset of the pandemic, researchers began to study the spread of remote employment during the period of restrictive measures and to construct a typical profile of remote workers based on various surveys [17–19]. Some studies have shown that such forms of employment in Russia are often associated with higher levels of job satisfaction and a greater amount of free time compared to standard forms of work [20, 21]. The issue of remote work efficiency has generally not been addressed by Russian scholars. The only notable exception concerns analyses of university faculty perceptions of the transition to large-scale online education during the pandemic, based on survey data [22–24]. It should be noted, however, that the studies mentioned above primarily focus on the periods immediately preceding, during, or following the COVID-19 pandemic. Nevertheless, working from home is not an entirely new phenomenon for the Russian labor market — it has been practiced in several industries for the past few decades.

DATA AND RESEARCH HYPOTHESES

The analysis of home-based employment in Russia was conducted using data from the Russian Longitudinal Monitoring Survey (RLMS-HSE) — a series of representative annual surveys carried out since 1994[3] by the National Research Uni-

[3] The Russian Longitudinal Monitoring Survey of the Economic Situation and Health of the Population (RLMS-HSE), conducted by the National Research University "Higher School of Economics" and LLC "Demoscope" with the participation of the Carolina Population

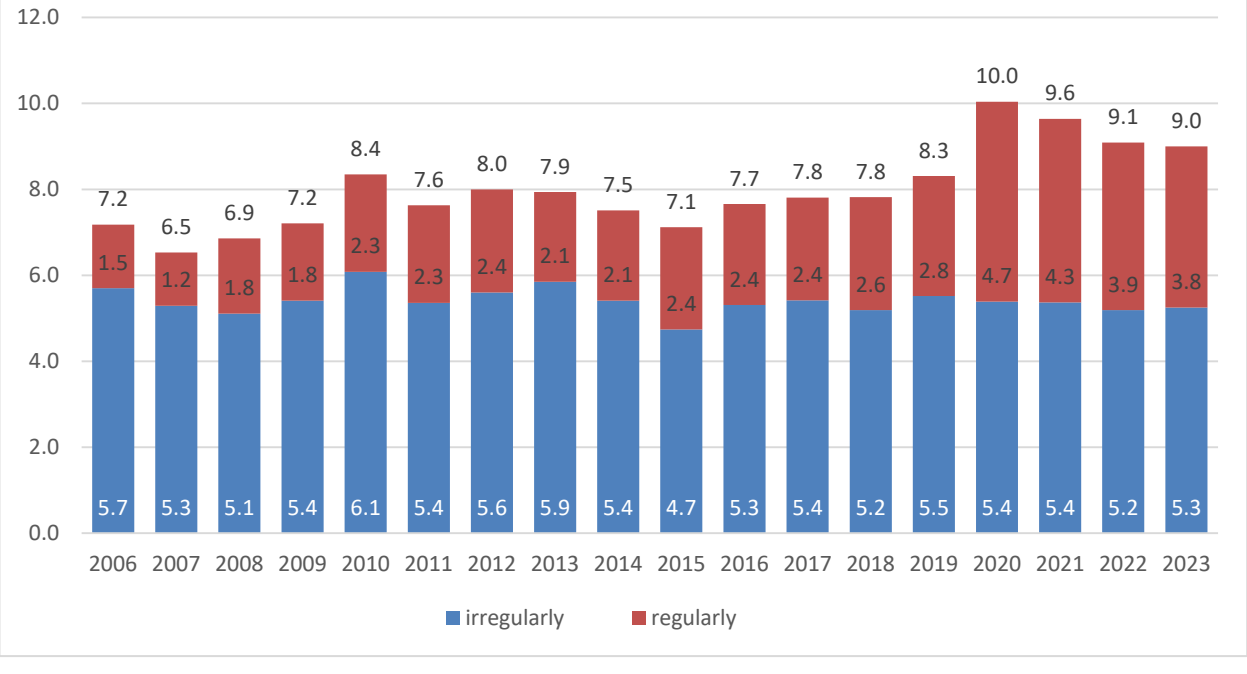

Fig. 3. **Trends in the Share of People Working from Home in Russia, 2006–2023, % of all employed**

Source: compiled by the authors.

versity Higher School of Economics. The micro-data provide detailed information on individuals' socio-demographic and family characteristics, as well as their educational and employment trajectories.

Since 2006, the questionnaire has included the question: "Have you worked from home at your main job during the past 30 days?" Respondents who answered affirmatively were classified in this study as home-based workers. It should be noted that this formulation allows identification of home-based employment only for the respondent's main job, which likely leads to an underestimation of the true scale of the phenomenon. To assess the intensity of home-based work, the following question was used: "How many hours did you actually spend working from home during the past 30 days?" Regular home-based employment was defined as working from home for at least half of the total hours devoted to one's main

Center at the University of North Carolina at Chapel Hill and the Institute of Sociology of the Federal Research Sociological Center of the Russian Academy of Sciences. ((RLMS-HSE survey websites. URL: http://www.hse.ru/rlms; https://rlms-hse.cpc.unc.edu)

Table 1

Socio-demographic Composition of People Working from Home, %

Indicator / Period	2006–2009	2010–2019	2020–2023
Gender			
Women	70.7	68.8	67.5
Men	29.3	31.2	32.5
Age group, years			
15–24	8.6	6.3	6.0
25–34	26.0	26.7	22.3
35–44	24.5	30.6	32.9
45–54	27.6	24.0	25.9
55+	13.2	12.4	12.8
Education			
Secondary or lower	13.6	11.6	9.3
Initial vocational	1.9	1.8	1.5
Secondary vocational	24.6	18.9	1.9
Higher education	59.9	67.7	72.4
Place of residence			
Rural area	25.4	21.0	18.8
City	56.2	61.6	59.3
Moscow or St. Petersburg	18.4	17.4	22.0
Self-assessed health			
Poor or very poor	8.0	5.5	3.0
Average	64.8	55.3	48.1
Good or very good	27.3	39.2	48.9

Source: compiled by the authors.

job over the past month; otherwise, such activity was classified as irregular.

Based on findings from studies in European countries, the following main hypotheses were formulated:

1. Individuals with higher levels of education are more likely to engage in home-based employment.
2. Employment in small organizations and self-employment increase the likelihood of working from home.
3. Living in urban areas has a positive effect on the probability of home-based employment.
4. Younger workers are more likely to work from home.

Before the pandemic, home-based work was not a widespread form of labor relations in the Russian labor market, similar to the situation in Eastern European countries. According to RLMS-HSE data (see *Fig. 3*), the share of respondents working from home ranged between 6.5% and 8.4% up to 2019, showing considerable volatility and no clear trend. In 2020, the proportion of home-based workers increased by only 1.7 percentage points compared to 2019. Population surveys indicate that at the peak of restrictions (May 2020), up to one-quarter of all employees were transferred to remote work, and in sectors such as education, IT, communications, culture, and sports, the share reached up to one-half [25]. However, the RLMS-HSE data show a much smaller increase, most likely because the survey was conducted between October and December, thus excluding the periods of the strictest COVID-19 restrictions. Over the next three years, the prevalence of home-based employment gradually declined, although by 2023 it remained above the pre-pandemic level. It is also noteworthy that in 2006, only one in five remote workers worked from home for at least half of their total working hours, whereas in 2020–2023, this figure rose to 42–46%, indicating a significant shift toward more regular home-based employment.

Table 1 presents the socio-demographic profile of individuals working from home in 2006–2009, when internet technologies were still relatively underdeveloped and access to the web remained limited; in 2010–2019, characterized by the rapid expansion of fast and inexpensive communication technologies; and in 2020–2023.

According to the RLMS-HSE data, the majority of remote workers were women. Although the share of men has shown a slight increase since 2006, they still accounted for only 32.5% of home-based workers in 2020–2023. The average age of such workers remained stable at 42 years throughout the observation period. At the same time, the proportion of both younger groups (aged 15–24 and 25–34) and older groups (aged 45–54 and 55 and over) declined. As a result, the largest share of those working from home currently falls within the 35–44 age group.

Another distinctive characteristic of those working from home is the predominance of individuals with higher education, a proportion that has steadily increased over time. While 59.9% of remote workers held a completed higher education degree in 2006–2009, this figure rose to 72.4% in 2020–2023. Accordingly, the share of those with lower levels of education declined significantly, most notably among individuals with secondary vocational education, whose proportion fell from 24.6% in 2006–2009 to 16.9% in 2020–2023.

Changes are also evident in the geographic distribution of remote workers. Whereas in 2006–2009 one in four remote employees lived in rural areas, by 2020–2023 this had decreased to one in five. At the same time, the number of urban residents, including those living in Moscow and St. Petersburg, increased. Currently, a remote worker is more likely to reside in a major city than in a rural area, a reversal of the pattern observed in 2006–2009.

Finally, the proportion of remote workers who rated their health as good or very good rose from 27.3% in 2006–2009 to 48.9% in 2020–2023. It should be noted that self-assessed health cannot serve as an objective indicator of the presence of medical conditions; nevertheless, such a substantial change likely reflects an actual improvement in the health of remote workers rather than solely shifts in perception. Moreover, the average age and gender composition of these employees

Table 2

Employment Characteristics of People Working from Home, %

Indicator / Period	2006–2009	2010–2019	2020–2023
Wage quintile			
1 (lowest wages)	12.7	12.9	11.8
2	17.0	18.8	16.4
3	26.0	22.1	17.3
4	18.6	20.1	20.8
5 (highest wages)	25.7	26.2	33.7
Employment status			
Self-employed	12.5	13.9	16.4
Employee (informal)	4.4	4.2	4.6
Employee (formal)	83.1	81.9	79.0
Occupation			
Managers	16.2	16,1	13,4
Professionals (high-skilled)	49.8	50.0	46.6
Associate professionals (medium-skilled)	18.0	18.3	23.2
Clerical support workers	2.3	2.2	3.9
Sales workers	6.8	7.8	7.5
Skilled manual workers	6.2	5.2	4.8
Unskilled workers	0.8	0.5	0.6
Industry			
Industry and agriculture	11.4	9.1	8.7
Construction	5.7	5.0	4.5
Transport	5.4	4.4	4.3
Public administration and security	5.4	4.8	3.2
Education and science	34.0	33.1	26.0
Healthcare	4.5	4.2	3.8
Knowledge-intensive services	10.9	14.2	19.7
Other services	22.7	25.1	29.8
Working time			
Part-time (<30 hours per week)	14.4	13.5	11.1
Full-time (30–40 hours)	52.6	55.5	62.7
Overtime (>40 hours per week)	33.1	31.1	26.3
Ownership of the enterprise*			
State-owned	60.8	57.2	45.2
Foreign-owned	3.0	3.2	4.4
Russian private owner	36.6	40.0	53.3
Respondent-owned	7.4	9.2	9.8
Enterprise size			
Micro	19.6	23.8	22.6
Small	53.7	52.7	52.9
Medium	11.6	9.9	8.9
Large	15.0	13.7	15.6

Source: compiled by the authors.

Note: * the amount in the column exceeds 100%, as there were several possible answers.

have remained largely unchanged, as noted above. This suggests that poor health is currently a less significant factor in the decision to engage in remote work than it was in 2006–2009.

At the same time, over the period under study, certain changes occurred regarding the typical workplace and nature of remote work, as shown in *Table 2*.

As shown in *Table 2*, since 2006 there has been an increase in the share of the fifth wage quintile (high-income groups) — from 25.7% in 2006–2009 to 33.7% in 2020–2023 — while the shares of the first three quintiles have gradually declined. In other words, home-based work today is primarily a prerogative of higher-income workers. However, even in 2006–2009 a similar pattern was observed, although the gap between groups was not as large as it is now.

According to RLMS-HSE data, most remote workers are employees, and only 4–5% of them work without formal employment contracts. At the same time, the share of the self-employed has somewhat increased — from 12.5% in 2006–2009 to 16.4% in 2020–2023.

Roughly half of all home-based workers are high-skilled professionals, and this indicator has remained relatively stable throughout the entire period. Meanwhile, the share of medium-skilled specialists increased from 18.0% in 2006–2009 to 23.2% in 2020–2023. Skilled and especially unskilled manual workers are underrepresented in this group, and their proportion has even slightly declined since the beginning of the observation period. Conversely, the share of sales workers has grown, most likely due to the development of technologies that make it possible to conduct such activities from home. Between 2006 and 2019, 16.1–16.2% of home-based workers were managers, but after 2020 this figure dropped to 13.4%.

In terms of industry, the distribution is also uneven: home-based workers are predominantly concentrated in services, education, and science. At the same time, the share of those employed in education and science has been steadily declining, while the share of those working in services has been growing — both in knowledge-intensive sectors (finance, law, IT) and in other services (trade, housing and utilities, catering). Thus, while in 2006–2009 33.6% of remote workers were employed in various service sectors (excluding the public and transport sectors), by 2020–2023 this figure had risen to 49.5%.

Only 11–15% of all remote workers put in less than 30 hours per week, while 26–33% work more than 40 hours. This suggests that for many, working from home remains a forced choice in the context of overtime. At the same time, part-time home-based work is relatively rare in Russia.

Over the period under study, the share of employees in state-owned organizations declined significantly — from 60.8% in 2006–2009 to 45.2% in 2020–2023. Meanwhile, the proportion of employees in privately-owned Russian enterprises increased — from 36.6% to 53.3% — as did the share of the self-employed, from 7.4% to 9.8%.

Furthermore, home-based workers are most often employed in enterprises or organizations with fewer than 100 employees, and this trend has remained consistent throughout the period. Specifically, 22.6% work in micro-enterprises (up to 15 employees), 52.9% in small enterprises (15–99 employees), and 8.9% and 15.6% in medium and large enterprises, respectively.

In summary, the typical home-based worker is a middle-aged woman with a higher education degree, living in a large city. In 2006–2009, there were more rural residents, younger and older employees, and individuals with secondary vocational or general education diplomas.

At the same time, since 2006, the range of professions and sectors where remote work occurs has remained largely unchanged: most often, these are individuals employed in education, science, or various service sectors, typically highly or moderately skilled specialists. The most significant change over the past decades has been a decline in the public sector share. This likely reflects the fact that in education, many workers have traditionally taken some work home — a pattern that has changed little over the last twenty years — whereas the number of home-based workers in other economic sectors has continued to grow.

Table 3

Results of Estimating the Determinants of Working from Home (Odds Ratios)

Indicator	Model (1)	Model (2)	
Variable	Working from home	Irregular work from home	Regular work from home
Men	0.718***	0.751***	0.643***
Age	1.007	1.005	1.008
Age squared	1.000	1.000	1.000
Place of residence (reference group – city)			
Rural area	0.932	0.915	0.986
Moscow or St. Petersburg	1.151*	1.078	1.376***
Education (reference group – secondary general or lower)			
Initial vocational	0.903	0.974	0.769
Secondary vocational	1.300***	1.323***	1.229
Higher education	2.291***	2.449***	1.857***
Self-rated health (reference group – average)			
Poor or very poor	1.396***	1.423***	1.325**
Good or very good	0.808***	0.786***	0.894*
) Wage (logarithm)	1.508***	1.487***	1.594***
Occupational group (reference group – high-skilled specialists)			
Managers	0.855**	0.911	0.638***
Mid-level specialists	0.480***	0.461***	0.519***
Office staff	0.265***	0.231***	0.350***
Service and trade workers	0.142***	0.133***	0.165***
Skilled workers	0.136***	0.121***	0.181***
Unskilled workers	0.043***	0.034***	0.048***
Industry (reference group – industry and agriculture)			
Construction	1.269**	1.507***	0.727
Transport	1.220*	1.232*	1.166
Public administration	1.079	1.088	0.989
Education and science	4.359***	4.657***	3.369***
Healthcare	0.750***	0.782*	0.627**
Knowledge-intensive services	2.141***	1.983***	2.469***
Other services	1.901***	2.029***	1.623***
Ownership – state-owned	0.867**	0.987	0.587***
Firm size (reference group – small, 15–100 employees)			
Microenterprise (⩽15 employees) / self-employed	1.290***	1.288***	1.324***
Medium (101–250 employees)	1.006	1.032	0.863
Large (>250 employees)	0.896	0.887	0.912
Employment type (reference group – formal employee)			
Not in organization	2.464***	1.812***	3.964***
Informal employment	1.582***	1.292**	2.264***
Working hours (reference group – full-time)			
Part-time	1.706***	1.093	4.449***
Overtime	0.825***	0.745***	1.113
Year	0.991**	0.981***	1.026***
2020-2021 г.	1.247***	1.065	1.685***
Federal district	+	+	+
Pseudo R^2	0.224	0.209	
Observations	86798	86798	

Source: compiled by the authors.
Note: *, **, *** indicate that the coefficient estimate is statistically significant at the 10%, 5%, and 1% levels, respectively.

ECONOMETRIC ANALYSIS OF DETERMINANTS OF HOME-BASED WORK

To analyze the determinants of working from home, a model was constructed and estimated, the general form of which is represented by the following formula:

$$Y_i = \alpha + \beta_1 \times X_{it} + \beta_2 \times Z_{it} + \beta_3 \times H_{it} + \varepsilon_{it},$$

Where:

Y_i – the dependent variable, indicating whether the individual worked from home;

X_{it} — a vector of variables representing the individual's socio-demographic characteristics (gender, age, level of education, place of residence, self-assessed health);

Z_{it} — a vector of variables describing the respondent's workplace (occupational group, industry, form of employment, enterprise size, ownership type, and working hours);

H_{it}— a vector of variables controlling for regional and temporal effects (federal district, annual trend, and a dummy variable capturing changes during the pandemic, equal to one for the 2020–2021 survey waves).

$\beta_1, \beta_2, \beta_3$— regression coefficients;

ε_{it}— random error term.

Two model specifications were employed.

In the first specification, the aim was to assess the impact of various factors on the probability of working from home. The dependent variable in this model took the value of "0" if the respondent had not worked from home in the last 30 days and "1" if they had. A logistic regression model was used for estimation, with standard errors clustered at the individual level.

In the second specification, the contribution of different determinants was evaluated not only for the probability of remote work but also for its duration. Accordingly, the dependent variable took the value of "0" if the respondent had not worked from home in the last 30 days, "1" if they had worked less than half of their total working time (irregular work from home), and "2" if they had worked more than half of their total working time (regular remote work). A multinomial logistic regression model was used to estimate the effect of the determinants on the duration of working from home, with standard errors similarly clustered at the individual level.

The estimation results are presented in *Table 3*. For each factor, the odds ratio is reported. For dummy variables, which constitute the majority in both model specifications, this value can be interpreted as the odds of working from home for an individual in the focal group (i.e., where the dummy variable = 1) relative to the odds for an individual in the reference group (where the dummy variable = 0). A value greater than 1 indicates higher odds of remote work for the focal group; a value less than 1 indicates lower odds. For continuous variables, a one-unit increase is expected to multiply the odds ratio by *exp(b)*, where *b* is the coefficient for the variable.

As shown in *Table 3*, the estimates from both model specifications are largely similar, though the second specification provides a more nuanced and detailed picture for certain determinants.

Among socio-demographic characteristics, gender and education level emerge as the most important factors. Men are significantly less likely than women to engage in remote work. Holding a secondary vocational or higher education degree increases the likelihood of irregular work from home, whereas regular remote work is primarily influenced by the presence of a higher education degree. Age does not have a significant effect. Residents of Moscow or St. Petersburg are more likely to work from home, particularly on a regular basis, while living in a rural area does not have a statistically significant impact on the probability of remote employment.

Health also plays an important role. Respondents who rate their health as poor or very poor are more likely to work from home, whereas positive self-assessments are associated with a lower likelihood of remote work.

Remote work — both regular and irregular — is significantly more common among higher-paid employees. This relationship remains robust even when controlling for industry, occupation, and

other workplace characteristics. High-skilled specialists are much more likely to work from home compared to other professional groups, while manual workers are the least likely. Remote employment is particularly concentrated in the education and science sectors, as well as in other service industries. Irregular remote work is relatively more common in construction and transport than in agriculture and industry, although no statistically significant differences are observed for regular remote work.

At state-owned enterprises, the probability of regular remote work is lower, while irregular remote work occurs at similar rates across different types of ownership. Employees of microenterprises, the self-employed, and workers without formal employment relationships are more likely to work remotely, which appears to reflect necessity rather than choice, as these individuals typically lack a designated workplace.

Working hours are an important determinant: regular work from home is significantly more likely among part-time employees (i.e., those working fewer than 30 hours per week) than among full-time or overtime workers, while irregular remote work is less common among those working overtime compared to full- or part-time workers.

Before 2020, a weak negative trend in remote work could be observed. The second specification of the model reveals a more complex pattern: irregular remote work declined, while regular remote work increased. The COVID-19 pandemic had a particularly strong impact on this trend: during 2020–2021, the odds of working remotely for an average worker increased by almost 25% when controlling for socio-demographic and occupational characteristics. Importantly, this effect applies only to regular remote work, as the probability of irregular remote work remained unchanged.

The results for Russia are consistent with international findings: individuals with higher education are more likely to work remotely. The hypothesis that employees of microenterprises and the self-employed, as well as residents of Moscow and St. Petersburg, are more likely to engage in work from home is also confirmed. However, the hypothesis that younger workers are more likely to work remotely is not supported: age was not found to have a significant effect in either model specification.

CONCLUSION

New technologies are transforming labor markets in most countries worldwide. The advent of the Internet, mobile communication, email, and the substantial increase in data transfer speeds has dramatically reduced the cost of remote communication over the past decades. Video conferencing, the ability to transmit large volumes of information, and instant delivery of official documents have become feasible. One consequence of the information and communication technology revolution has been a shift in the geography of work. The share of individuals working from home has steadily increased since the early 2000s in most developed countries. Thus, these new communication tools enabled countries in 2020 to implement strict measures to curb the spread of COVID-19 while mitigating the economic and social impact, as a substantial portion of the population was able to transition to remote work, many continuing to do so at least part-time. It can be assumed that fifty years ago, the societal consequences would have been far more severe.

Russia, however, has followed international trends only partially. According to HSE RLMS data, the share of people working from home in Russia between 2006 and 2019 remained largely unchanged. After a sharp increase during the pandemic, this figure has returned almost to pre-pandemic levels, meaning that remote work is currently less widespread in Russia than in Europe or the United States.

Nonetheless, the transformation of remote work into a distinct segment of the labor market aligns Russia with other countries worldwide. Since 2006, the prevalence of regular work from home (more than half of total working hours) has been increasing. The profile of remote workers has also changed: in 2006–2009, a significant portion comprised low- and medium-skilled in-

dividuals, including both younger and older age groups, often with average or poor health, and many residing in rural areas. By 2020–2023, the majority are middle-aged individuals with higher education, urban residents — particularly in large cities — and in relatively good health. Remote work is now almost exclusively concentrated in the service sector, with digital telework likely becoming the dominant format. However, it is important not to overstate the scale of these changes: even before 2010, remote work was primarily prevalent among higher-income groups.

At the same time, the share of irregular remote work in Russia remains comparatively low. Even amid recent labor shortages, employers have not actively sought to provide employees with more flexible working conditions, despite a substantial portion of workers expressing a desire to adopt hybrid schedules. This may be explained by managerial concerns that such arrangements could lead to significant declines in labor productivity. Consequently, the recent growth in remote work has largely been driven by its expansion among the self-employed and employees of microenterprises.

The shift of organizations toward remote work has the potential to partially mitigate the effects of labor shortages in Russia. Although there is currently increased demand for manual and engineering-technical professions, which cannot be performed remotely, the spread of work-from-home arrangements could reduce regional labor imbalances if employers in labor-deficit regions begin to attract employees from areas with a surplus of labor and high unemployment. Moreover, flexible forms of employment may engage previously excluded population groups in economic activity. This would lead to higher overall labor force participation and partially offset the shortage of human resources exacerbated by the demographic crisis. However, to achieve maximum impact, development of digital infrastructure and adjustments in corporate strategies are required.

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