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Financial Instruments of Economic Mechanisms for Strategic Development of Science and Education: Ecosystem Approach

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ABSTRACT

The authors substantiate the importance of choosing efficient financing instruments for the successful functioning of economic mechanisms that ensure the implementation of strategic priorities for economic development. The study shows that the spheres of science and education have a direct positive impact on the growth of the economy, being important priorities and drivers of economic development. Accordingly, it is necessary to develop clear strategic guidelines for the development of these areas and define financial instruments embedded in economic mechanisms to ensure their practical implementation. In this regard, **the aim** of the study is to conduct a retrospective analysis of science and education funding, considering international and domestic experience, to propose the conceptual content of sectoral strategies for the development of science and education at different levels of the economic hierarchy, and to identify financial instruments to ensure appropriate strategies. Based on the use of theoretical, empirical, comparative, institutional, and evolutionary analysis of international and domestic experience in science and education funding, the expediency of implementing an ecosystem approach to the development and funding of these areas is substantiated, which makes it possible to unite all interested participants in socio-economic ecosystems through partnerships and resource flows. The paper substantiates the importance of distinguishing between sectoral strategies for the development of science and education and suggests the content of the corresponding strategies at the macro-, meso-and micro-levels of the economy. The research contains a comprehensive analysis of the financing instruments and economic mechanisms for the development of science and education in Russia from 1992 to the present, taking into account their effectiveness. It also includes the study of new promising instruments for science and education. Based on the results of this analysis, the authors **conclude** that it is advisable to rely on those financing instruments that have a self-reproducing nature and allow forming the economy of science on the basis of the ecosystem approach and assume a balance of private and public funding.

Keywords: financial instruments; science and higher education funding; strategic development; transformation of the spheres of science and education; ecosystem approach; economic mechanisms; sectoral strategies

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INTRODUCTION

Finance in the modern world of science and education needs effective instrumental support. This will enable financial support instruments to become a basic element of economic mechanisms, determining the effectiveness of the implementation of various priorities for the development of society. The effectiveness of financial instruments in ensuring economic performance is determined by how correctly strategic priorities and adequate development mechanisms are chosen and the tools for their financial support are correctly formed. It is about the importance of coordinating relations in the system of "strategic development priorities — economic mechanisms for their implementation — financial instruments of support".

In the transformation of the Russian economy in accordance with the given principles, directions and mechanisms of strategic development, the role of the main driver reasonably belongs to science and education. The scientific sphere creates a scientific and technological basis for the modernization of industries and territories, which ensures economic growth and brings the economy to a new technological level. The results of scientific research are associated with sectoral priorities for the transformation of the economy and focuses of industrial policy, with the achievement of sustainable development goals and the mitigation of strategic risks and threats to national security.

According to the results of varous research, there is a close positive relationship between scientific and technological achievements and economic growth [1]. Jokanović, B. Lalic, M. Milovančević, N. Simeunović and D. Marković prove the impact of scientific and technological development on economic growth using artificial neural networks [2].

The study of the function of knowledge production, which is central to growth models based on research and development, is carried out in the studues of Yasser Abdih and Frederick Joutz [3].

Mingran Wu, Min Zhao, Zhaodan Wu prove that scientific and technological innovations are a key driving factor in economic development and social progress on the example of the regions of eastern China [4].

Philippe Aghion and co-authors explore the impact of science, technology and innovation on economic development and growth [5, 6] and attempt to apply "systems-theoretic" approaches to the interdependent study of policy issues related to the dynamics of science, technology and innovation and economic growth [7]. Scholars point out that technology and innovation policies for economic growth are widely recognized, but they immediately become politically controversial when their implementation goes beyond supporting "far from commercialization" research and includes specific details that affect various markets, institutions and industries [7].

Further, high-quality education, ultimately focused on the use of modern digital transformation opportunities, is the main condition for the development of human capital, improving the quality of life and well-being of the population, as well as the most important factor in economic development in general [8, 9]. The underdevelopment and spread of education are the reasons why a number of developing countries cannot realize the full package of benefits of technological progress [10].

Studies conducted using empirical data for Bosnia and Herzegovina confirm the significant positive role of science and education in economic development [11].

An assessment of the relationship between higher education and economic growth obtained as a result of a longitudinal study of European regions over 2000–2017, showed that an increase in the number of universities in a region contributes to stronger economic growth in this region, and the growth of GRP per

capita is largely due to the expansion of higher education [12].

The study of Fateh Habibi and Mohamad Amjad Zabardast shows the relationship between education and the impact of digitalization on economic growth [13]. For example, in countries with better access to education, information and communication technologies have a more beneficial effect on economic growth and contribute to the expansion of economic value creation through the Internet [13].

Various studies confirm the positive impact of education on economic growth [14, 15]. At the same time, it is necessary to increase the efficiency of investments in higher education, optimize the distribution of resources in the system of higher education and science, and improve the quality of higher education to ensure the dynamic development of the economy [16].

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Consequently, science and education play a key role in modern society, determining the progress of modern high-tech production and the success of the sustainable transformation of the economy. Moreover, it is important how the development of science and education is regulated. For example, in Russia, the Strategy for Scientific and Technological Development of the Russian Federation notes that between 2004 and 2018, "the number of scientific workers under the age of 39 has increased by about 30 percent, and the general age structure of scientific personnel has noticeably leveled off. Russian schoolchildren and students traditionally find themselves among the leaders of international competitions in the field of natural and technical disciplines, but not all of them fulfill their potential in this area. This does not allow overcoming the existing negative trends in terms of the demographic state, qualifications and level of mobility of Russian researchers".[1] In this context, on the one hand, it is necessary to develop strategies for the development of these sectors of the economy, search for mechanisms and development tools that are adequate to the conditions of the internal and external environment. On the other hand, in practice those strategies are implemented that have sufficient and effective financial support, which determines the importance of choosing the appropriate tools.

Studies of sources and financial instruments for ensuring the development of science and education are conducted actively by various countries, invariably maintaining their relevance and debatableness [18–26].

Foreign experience and best practices in financing science and education can and should be used, but rationally and partially, since financial instruments should be formed in accordance with the content of countries' strategies for the development of science and education and take into account the effectiveness of the accumulated experience of their financing. The analysis showed that in the scientific literature there is a gap between the recognition of the leading role of science and education in economic development and the content of strategies and tools for financial support for the development of these areas. With this in mind, this study is aimed at a retrospective analysis of the financial instruments for science and education, considering world and domestic experience, the conceptual content of the strategies for the development of science and education at different levels of the hierarchy of the economy and the specification of financial

[1] Decree of the President of the Russian Federation of December 1, 2016, No. 642 "On the Strategy for the Scientific and Technological Development of the Russian Federation". URL: http://kremlin.ru/acts/bank/41449 (accessed on 02.07.2021).

Table 1

Expenditure on education, 2018

Country	Expenditure on education, mln USD	Expenditure on education, % of GDP	Government expenditure on education, % of GDP	Non-government expenditure on education, % of GDP
Russia	156,250.6	4.1	3.6	0.5
Australia	80,880.1	6.6	4.3	2.3
US	198,028.5	6.7	4.5	2.2
Germany	229,517.5	5.2	4.5	0.7
Italy	110,769.6	4.4	3.8	0.6
New Zealand	13,708.5	7.3	5.4	1.9
USA	–	6.1	4.2	1.9

Source: compiled by the authors.

instruments for providing appropriate strategies. At the same time, the main attention is focused on the areas of higher education and science and universities as their main subjects.

WORLD EXPERIENCE IN HIGHER EDUCATION AND SCIENCE FUNDING: INSTRUMENTAL COMPONENT

An analysis of the world experience in financing science and higher education shows that the effectiveness of specific financial instruments is determined by the consistency of their integration into existing economic mechanisms. Financial instruments should be considered in their respective social and economic context. Higher efficiency is demonstrated by those tools that are adaptive in relation to other economic factors.

In most continental European countries, higher education is primarily free. At the same time in other advanced economies (including the US, UK, Australia, and New Zealand) students must pay university fees, often using loans. Different higher education financing instruments show different performances in different countries. Thus, Ngo Van Long believes that a state-run conditional income loan scheme (according to which the amounts that people must pay in a certain period depend on their income in this period) is an effective and fair way to finance higher education [15]. Further, a number of scholars note that the US student loan system is experiencing significant difficulties; in 2018, about 7 million borrowers were in default, and the amount of overdue debt amounted to more than $ 1.3 trillion [27]. This is largely determined by the characteristics of the education financing instrument (fixed payments over a certain period to pay off a student loan). The instruments of England and Australia, which use the system of loan repayment considering income in a specific period of time, are considered to be more flexible and efficient [27]. *Table 1* shows spending on education in different countries in an aggregated form.

It should be noted that it is in Australia, England, New Zealand and the United States

that non-state expenditure on education in relation to GDP is about 2%.

In turn, Limor Hatsor notes that during the transition of a number of countries from public to private financing of higher education (through student loans), the corresponding financial decisions have become an individual choice, the risks of which are due to the inevitable collision of potential students with uncertainty about their future human capital [18].

Economic factors influencing the educational choice of potential students (predicted future salary, tuition costs, the possibility of budgetary support, etc.) were analyzed using fuzzy logic methods in the studies of A. A. Tarasyev, G. A. Agarkov, C.A. Ospina Acosta, V.A. Koksharov [28].

Attempts to form effective instruments for financing higher education, involving a combination of public and private funding, but with a predominant reliance on the private sector, are being undertaken by South Korea [30].

W. James Jacob, Ka Ho Mok, Sheng Yao Cheng, Weiyan Xiong show that in today's global environment, national competitiveness is determined by university innovation and development based on a large-scale study of the development effectiveness and financing mechanisms of higher education systems in China, Hong Kong and Taiwan. Since the beginning of the 21st century, higher education in this region has been privatized, universities are forced to look for alternative sources of funding, and not depend solely on the state. There is also a growing need for partnerships between universities and industry [31].

An analysis of the European experience shows that the partnership of universities and corporations can create conditions for expanding the participation of the industry in the financing of higher education, but the growth of investment in education must be accompanied by an adequate performance by universities of their role in the triple helix model, which is implemented in close interaction between the state, universities and business in the innovation process [20].

Over the last 40+ years, higher education in the UK has moved from a publicly funded system to a mixed public and private funding system driven by a consumer market based on student loans, in which both the postgraduate student and the institution share a significant responsibility in the total cost of tight state control [32]. Restrictions on public funding, increased competition, and drastic reductions in resources per student have institutionalized constant pressure on universities to reduce costs, leading to the development of effective financial management. This has become the main factor in the formation of market culture and the high efficiency of higher education in the UK in terms of the ratio of invested financial resources and the results obtained [32].

When considering the scientific and technological areas in the activities of institutions of higher education and science, it is important to note that world experience indicates that the lack of funding to ensure the transfer of scientific ideas and developments from universities to industry is a serious obstacle to the effective commercialization of university technologies [21–23]. To address this problem, universities have invested in creating internal funding mechanisms to support translational research and stimulate the growth of academic spin-offs, often in collaboration with government agencies [21]. Various support mechanisms aim to address funding gaps, both as a general policy framework and through specific institutional initiatives, including university accelerators and incubators, innovation programs, start-up competitions, and university-run seed funds [33–35]. At the same time, administrators of financial programs to support technology transfer at universities should strive to establish and develop fruitful and systematic links and cooperation with external investors to create a comprehensive and effective funding system [36].

As the analysis of foreign experience shows, despite the different combination of funding tools for science and education and their different performance, the relevance of co-financing the development of universities with the involvement of various actors and sources and building partnerships with industry and the state to achieve significant results is consistently recognized. Scientists also highlight the importance of coordinating relations and interaction of all participants in the financing of higher education in student loan mechanisms (students, banks, universities) [37]. This gives grounds to conclude that it is expedient to develop tools for financing science and education from the standpoint of the ecosystem approach. Under the socio-economic ecosystem in this case, in accordance with the definition of G.B. Kleiner is understood as "a localized complex of organizations, business processes, innovative projects and infrastructure formations, capable of long-term independent functioning due to the turnover of resources, products and systems" [38]. In the conditions of the new economy, it is ecosystems that have significant opportunities in the context of solving the problems of strategic development [39]. In this case, we are talking about financing not individual entities in the field of science and education, but about creating financial incentives for scientific and educational ecosystems, in which symbiotic and partnership relations ensure more efficient distribution and rational use of financial resources.

INSTRUMENTS FOR FINANCING SCIENCE AND EDUCATION IN RUSSIA

In the Russian Federation for the period from 1995 to 2021, a number of economic, financial and legal instruments related to the innovative transformation of science and education have been implemented and continue to be implemented. At the same time, the problem remains important in terms of the use of financial instruments in the scientific sphere, the assessment of the payback of developments, the expected return from them, and the overall impact on the technological development of the economy [40].

One of such financial instruments of the transformation mechanism is the Order of the Government of the Russian Federation of April 9, 2010 No. 218[2] (hereinafter — Order-218). Order-218 provides for state support for the development of cooperation between enterprises in the industrial sector, Russian educational institutions of higher education, and scientific organizations through joint research and development work ordered by enterprises in the real sector of the economy from universities and scientific institutions.

The mechanism proposed by the state in the form of Order-218 is implemented through subsidizing research and development work in order to stimulate scientific and educational activities in Russian universities, use the potential of Russian educational and scientific organizations for industrial enterprises to develop science-intensive production and innovative activities in the Russian economy. It should be noted that in accordance with the requirements for the implementation of the project, for 1 invested state ruble, it is necessary to attract 1 ruble of extra-budgetary funds, i.e. ensure 100% co-financing of the project. Each organization — the winner of the competition receives up to 100 million rubles per year, and the project is carried out for three years.

This financial instrument of the transformation mechanism has been implemented for more than 10 years (from 2010 to the present), and its financial support for the entire period of the project is more than 50 billion rubles of subsidies and

[2] Order of the Government of the Russian Federation of April 9, 2010, No. 218 "On approval of the Rules for granting subsidies for the development of cooperation between Russian educational institutions of higher education, state scientific institutions and organizations in the real sector of the economy in order to implement comprehensive projects to create high-tech industries" (as amended on February 15, 2021).

more than 64 billion rubles of co-financing from extrabudgetary sources. From 2010 to 2018, 10 competitions were held, as a result of which 364 projects for the formation of high-tech production were implemented and continue to be implemented.[3]

Further, it should be noted that over the eight years of the implementation of this financial instrument of the transformation mechanism, a wide range of results have been achieved:

1. More than 5000 students, 2000 graduate students, and 4000 young scientists took part in R&D, the share of their salaries was more than 55% [41]. More than 8,000 jobs have also been created, including about 5,000 jobs for young scientists (specialists), which makes it possible to call this financial instrument an effective element of a transformational mechanism for supporting young scientists, graduate students, and students.

2. During the implementation of this measure, 6352 scientific articles were published, including 1385 articles in foreign journals indexed in the Web of Science, Scopus, Web of Knowledge, Astrophysics, PubMed, Mathematics, Chemical Abstracts, Springer, Agris, GeoRef. Also, the significant scientific results of the project include the number of Russian and foreign patents filed and received — 1854 applications and 1214 patents, respectively.

3. During the implementation of Order-218 as a financial instrument of the scientific and technological transfer mechanism, about 500 units of innovative products were developed, of which 316 were sold at the stage of mass industrial production and in general over 2010–2017 new (improved) products were produced with worth more than 770 billion rubles.[4]

The effectiveness of this financial instrument is confirmed by the fact that for each ruble of budgetary funds, products worth at least 11 rubles were produced, and if extra-budgetary co-financing is taken into account, then within the framework of the project, products worth 5.5 rubles were produced for each ruble of subsidy received.

Table 2

Financial support for Project 5–100

Year	Subsidies, mln rubles
2013	8,700
2014	10,150
2015	10,140
2016	10,927
2017	10,310
2018	9,908
2019	9,901
2020	10,072
Total	80,108

Source: compiled by the authors on the basis of the Decree of the Government of the Russian Federation "On subsidies provided from the federal budget for state support of the leading universities of the Russian Federation in 2013–2020".

Moreover, as a tool, it should be noted the action plan for the development of leading universities, which provides for increasing their competitiveness among the world's leading scientific and educational centers (Project 5–100),[5] which was implemented in 2013 and was aimed at improving the quality of education, developing science, strengthening interaction with enterprises in the real sector of the economy, the development of human resources, internationalization and the formation

[3] Analytical materials of the Ministry of Education and Science of Russia. URL: http://p218.ru/ (accessed on 28.06.2021).

[4] Analytical materials of the Ministry of Education and Science of Russia. URL: http://p218.ru/ (accessed on 28.06.2021).

[5] Order of the Government of the Russian Federation of October 29, 2012, No. 2006-r "On approval of the action plan for the development of leading universities, providing for increasing their competitiveness among the world's leading scientific and educational centers".

of a reputation both among the academic community and among employers.[6] The implementation of this project was carried out by 21 universities: in 2013, 15 universities were selected, and in 2015–6 universities.

It should be noted that over the six years of the implementation of this project, a wide range of results have been achieved[7]:

- the number of enterprises that are practice bases increased from 15,673 in 2013 to 36,006 in 2018;
- in 2018, 409 educational programs leading to obtaining double diplomas were implemented, since 2013 more than 1.5 thousand new educational programs have been introduced, developed jointly with leading foreign and Russian educational institutions of higher education;
- since 2013, the number of young scientific and educational research workers (ERWs) involved [42] has amounted to about 7.5 thousand people;
- in 2019, more than 10 thousand programs of international and domestic academic mobility of the ERWs were implemented in the form of internships, advanced training, professional retraining and other forms, an increase compared to 2013 amounted to 2.5 times (2013–3924 programs); also, in 2019, 21,598 foreign and Russian faculty members visited the winning universities;
- the proportion of foreign citizens from among the ERWs in the total number of ERWs increased five times (from 2013–0.8% to 2018–4%); the number of foreign researchers — by 3.9 times (from 2013–428 people to 2018–1664 people).

It is important to note that the financial support of Project 5–100 from 2013 to 2020 at the expense of subsidies amounted to about 80 billion rubles (*Table 2*). At the same time, co-financing from extrabudgetary sources, which is mandatory in accordance with the requirements for the implementation of Project 5–100, amounted to more than 55 billion rubles for the entire implementation period.

Many governments use financial mechanisms similar to the Russian Project 5–100: China Excellence Initiatives (Project 211), Centres of Excellence in Finland. These projects/programs have been implemented since 1995. In South Korea (Brain Korea 21) since 1999, in Canada (Canada Research Chairs Program) since 2000.[8] Their specific design is determined by the content of the respective strategies for the development of science and education.

STRATEGIC COMPONENT OF REALIZING THE POTENTIAL OF SCIENCE AND EDUCATION: ECOSYSTEM APPROACH

Despite many connections that permeate the spheres of science and education, their interconnectedness and interdependence, the corresponding systems solve different problems of transforming the economy. This actualizes the development of sectoral strategies for the development of the education system and the system of science and higher education. Currently, there are no coherent strategies for the development of these systems and corresponding funding mechanisms.

Various goals, objectives, institutions, and mechanisms associated with the transformation of these areas in accordance with the responses to major challenges and more local problems are distributed across various strategies, programs, and projects of different directions and levels, development efficiency is often recorded as secondary formal indicators. As a result, a large number of barriers, both semantic and resource-based, arise to the systematic development

[6] Order of the Government of the Russian Federation of March 16, 2013, No. 211 "On measures of state support for leading universities of the Russian Federation in order to increase their competitiveness among the world's leading scientific and educational centers".

[7] Analytical materials of the Ministry of Education and Science of Russia. URL: https://www.5top100.ru/news/ (accessed on 28.06.2021).

[8] The main results of the implementation of Project 5–100 in 2013–2020 FGANU "Center for Sociological Research". Moscow; 2020. p. 68.

of the scientific and educational spheres, which, in turn, acts as a deterrent to the transformation of the country's economy at all levels of government. Socio-economic, scientific, technical, digital, educational, financial inequality is accumulating between different economic entities, which, on the one hand, significantly reduces the connectivity of the entire economic system, on the other hand, does not allow reaching a critical mass of human capital with those qualitative characteristics that necessary for a successful systemic transformation of the economy.

In order for the systems of science and education to realize (to achieve) their purpose (mission) in this context, it is first of all necessary to develop specialized sectoral strategies for the development of these systems and to carry out their structural decomposition. Such a division will make it possible to form clear guidelines and identify a qualified customers of multi-level systems working to implement the overall strategy for transforming the Russian economy. Thus, from the personnel point of view, the goal of the strategy for the development of the system of science and higher education is the reproduction of scientific and educational research personnel. A necessary condition for achieving this goal is the creation of a qualified customer in the face of industrial partners, universities, research organizations and other entities interested in scientific transfer.

Despite the importance of strategizing the systems of science and education at the macro level, the high heterogeneity of territories, environments and spaces of Russia requires a combination of a universal strategic macroeconomic component with meso-economic strategies for the development of the territories under consideration, determined by territorial and sectoral features and embedded in them microeconomic strategies for the development of institutions of science and education.

Accordingly, at the macro level, the main accompanying guidelines for the development strategies of science and education systems should be:

- determination and fixation of sustainable transparent strategic goals on the long-term horizon of planning the development of science and education in conjunction with other economic development strategies;
- formation of an actual educational and scientific agenda;
- consolidation on one methodological platform of both new and already tested mechanisms and tools for the development of science and education, taking into account their institutional, organizational, managerial and resource support;
- development of new substantive criteria for the development of science and education with long-term trends and guidelines;
- development and creation of an intelligent mechanism for managing the development of science and education systems based on the concept of data-based management using digital technologies and building feedback [40];
- integration of information on a single platform of science and education and the formation of a verified knowledge space using digital technologies (primarily blockchain), the creation of verified knowledge bases, "live" laboratories for the implementation of relevant projects, which will make it possible to make a transition to a knowledge economy;
- development of conditions and creation of mechanisms for involving stakeholders in the development and implementation of strategies for the development of science and education on the basis of network and partnership mechanisms, including scientific and research and production organizations, educational institutions of all levels of training, alumni associations, industrial partners, specialized non-profit organizations, etc. Such mechanisms are joint working groups and development

Table 3

Science and education financial mechanisms

Implementation year	Financial mechanism — projects/programs	Project / program objectives	Financial support for the project/program
1992	Creation of the Russian Foundation for Basic Research (Decree of the President of the Russian Federation of April 27, 1992, No. 426 "On Urgent Measures to Preserve the Scientific and Technical Potential of the Russian Federation")	Conducting a competitive selection of the best science projects from among those submitted by scientists on their own initiative, and subsequent organizational and financial support for supported projects	Annually, financial support changed from 18 million rubles in 1993 to 11,578 million rubles in 2017 [Website of the Russian Foundation for Basic Research. URL: https://www.rfbr.ru/rffi/ru/fundbudget (accessed on 02.07.2021)]
1993	Formation of large scholarship programs (Scholarships of the President of the Russian Federation (Decree of the President of the Russian Federation of September 6, 1993, No. 613-rp "Regulations on Scholarships of the President of the Russian Federation") and scholarships of the Government of the Russian Federation) (Order of the Government of the Russian Federation of April 6, 1995, No. 309 "On the Establishment of the Russian Government Scholarships for Graduate Students and Students of State Organizations Engaged in Educational Activities on Educational Programs of Secondary Vocational Education and Higher Education")	Preservation and development of the intellectual potential of the Russian Federation and strengthening of state support for students and graduate students of educational institutions of higher professional education	The annual amount of financial support has changed since 2009 and amounted to 56 million rubles and 2.4 million US dollars for studying abroad
1994	The establishment of the Russian Humanitarian Science Foundation (Order of the Government of the Russian Federation of September 8, 1994, No. 1023 "On the Russian Humanitarian Science Foundation")	Support for the development of the humanities, the enhancement of accumulated scientific knowledge and its wide dissemination in society, and the revival of the traditions of domestic humanities	Financial support changed annually, in 2016 it amounted to 1,800 million rubles
1997	Federal target program "State Support for the Integration of Higher Education and Fundamental Science in 1997–2000" (Decree of the President of the Russian Federation of June 13, 1996, No. 884 "On the Doctrine of the Development of Russian Science")	Deepening the expansion of interaction between academic and university science, improving the quality of education in order to preserve and develop the scientific and technical potential of the country	Total financial support of the project is 3.158 billion rubles (in 1996 prices)
2005	Priority National Project "Education"	Stimulation of innovations in the field of education; modernization of schools; support for talented youth; organizing a network of national universities and business schools; development of a system of motivation for teachers	Financial support of the project is 61,952 million rubles (A.S. Matienko. Priority National Project "Education": Essence and Problems of Implementation. Yearbook of Russian educational legislation. 2007. Vol. 2. p. 188–210. URL: https://elibrary.ru/item.asp?id=15552053& (accessed on 02.07.2021)

Table 3 (continued)

Imple-menta-tion year	Financial mechanism — projects/programs	Project / program objectives	Financial support for the project/program
2006	Formation of a network of federal universities (Decree of the President of the Russian Federation of May 7, 2008, No. 716 "On Federal Universities")	Assistance in the systemic modernization of higher professional education based on the integration of science, education and production, training qualified personnel to meet the long-term needs of an innovative economy	Financial support of the project was carried out within the framework of the Priority National Project "Education".
2008	Formation of a network of national research universities (Decree of the President of the Russian Federation of October 7, 2008, No. 1448 "On the Implementation of a Pilot Project to Create National Research Universities")	Implementation of priority areas for the development of science, technical, technological, scientific and personnel support for the needs of the economy and social sphere	Financial support of the project was part of the Priority National Project "Education"
2009	Federal Target Program "Scientific and Educational Research Personnel of Innovative Russia"	Improving the living standards and professionalism of domestic specialists, creating a clear system to stimulate the influx and retention of young promising scientists.	Total financial support of the project is 80 billion rubles.
2010	A set of resolutions of the Government of the Russian Federation (Order of the Government of the Russian Federation dated 09.04.2010 No. 218 "On Approval of the Rules For Granting Subsidies for the Development of Cooperation Between Russian Educational Institutions of Higher Education, State Scientific Institutions and Organizations in the Real Sector of the Economy in Order to Implement Integrated Projects to Create High-Tech Industries" (as amended on February 15, 2021); (Order of the Government of the Russian Federation dated April 9, 2010, No. 219 "On State Support for the Development of Innovative Infrastructure in Federal Educational Institutions of Higher Professional Education"	Order-218 — development of cooperation between Russian higher educational institutions, scientific institutions and industrial enterprises. Order-219 — development of innovative infrastructure, including support for small innovative entrepreneurship, in federal educational institutions of higher education. Order-220 — creation under the guidance of world-class scientists of laboratories conducting research at the forefront of the development of science and technology (Order of the Government of the Russian Federation of 04/09/2010 No. 220 «On Measures to Attract Leading Scientists to Russian Educational Organizations of Higher Education, Scientific Institutions and State Scientific Centers of the Russian Federation"	Financial support of the project in total: Order-218 more than 50 billion rubles Order-219 more than 3 billion rubles Order-220 more than 12 billion rubles

Table 3 (continued)

Implementation year	Financial mechanism — projects/programs	Project / program objectives	Financial support for the project/program
2013	Project 5–100 (Order of the Government of the Russian Federation dated March 16, 2013, No. 211 "On Measures of State Support for Leading Universities of the Russian Federation in Order to Increase their Competitiveness Among the World's Leading Scientific and Educational Centers")	Maximizing the competitive position of a group of leading Russian universities in the global market for educational services and research programs	Total financial support of the project is 80 billion rubles
2013	Pilot project on the creation and development of centers for breakthrough research in the field of information technology	The project is aimed at creating scientific centers based on scientific organizations and universities that carry out breakthrough research and development in the field of world-class IT and targeted training of personnel, as well as the implementation of effective principles and forms of science integration, education and business	Total financial support of the project is 4 billion rubles
2013–2014	Support programs for engineering centers (State Program of the Russian Federation «Development of Industry and Increasing its Competitiveness», approved by Order of the Government of the Russian Federation of April 15, 2014, No. 328)	The development of the engineering industry and the formation of the domestic industrial design industry, the development of small and medium-sized businesses in the engineering and industrial design industry	Financial support of the program: 2013–500 million rubles 2014–530 million rubles
2013–2014	Federal target program "Research and development in priority areas of development of the scientific and technological complex of Russia in 2014–2021" (Order of the Government of Russia dated May 21, 2013, No. 426 "On the Federal Target Program «Research and Development in Priority Areas of Development of a Scientific and Technological Complex of Russia in 2014–2020")	Creation and support of an innovative infrastructure designed to connect the research sector with the subjects of a market economy, to ensure the conversion of knowledge, and their transformation into a market product	The financial support of the program is only 171 billion rubles. [Website of the Federal Target Program. URL: http://fcpir.ru/about/ (accessed on 02.07.2021)]
2014	FTP: Federal target program "Scientific and educational research personnel of innovative Russia" in 2014–2020» (Order of the Government of the Russian Federation dated 08.05.2013 No. 760-r "On the Concept of the Federal Target Program "Scientific and Educational Research personnel of Innovative Russia" in 2014–2020"	Development of a system for the effective reproduction of highly professional personnel in the scientific and scientific-educational sphere and increasing their competitiveness at the global level	Total financial support for the program is 201 billion rubles. [Website of the Federal Target Program. URL: https://fcp.economy.gov.ru/cgi-bin/cis/fcp.cgi/Fcp/Passport/View/2014/415/ (accessed on 02.07.2021)]
2014	Establishment of the Russian Science Foundation (Federal Law of November 2, 2013, No. 291-FZ "On the Russian Science Foundation and Amendments to Certain Legislative Acts of the Russian Federation")	Financial and organizational support for fundamental scientific research and exploratory scientific research, training of scientific personnel, and development of scientific teams	The annual financial support changed from 7.59 billion rubles in 2014 to 21 billion rubles in 2020 [RFBR website. URL: https://www.rfbr.ru/rffi/ru/fundbudget (accessed on 02.07.2021)]

Table 3 (continued)

Implementation year	Financial mechanism — projects/programs	Project / program objectives	Financial support for the project/program
2014	Programs of the National Technology Initiative	Formation of fundamentally new markets and creation of conditions for the global technological leadership of Russia by 2035	Financial support is secured within the framework of individual competitions
2015	Formation of a network of flagship universities (Order of the Ministry of Education and Science of Russia dated August 7, 2015, No. 811 "On the Competitive Selection of Educational Institutions of Higher Education for Financial Support of Development Programs for Federal State Educational Institutions of Higher Education at the Expense of the Federal Budget in 2016–2018")	Creating conditions for the effective development of Russian education, aimed at ensuring the availability of quality education that meets the requirements of the modern innovative socially oriented development of the Russian Federation	Total financial support of the project is 1,594 million rubles
2016	Priority project "Universities as Centers of Space for Creating Innovations". The priority project "Universities as centers of space for creating innovations" was approved by the Presidium of the Council under the President of the Russian Federation for Strategic Development and Priority Projects (dated October 25, 2016 No. 9)	Ensuring the global competitiveness of leading Russian universities	Total financial support of the project is 44 618 million rubles
2018	National Projects "Science" and "Education" (as amended in 2020 National Projects "Education" and "Science and Universities")	Education — providing opportunities for self-realization and development of talents. Science and universities — ensuring the presence of the Russian Federation in the top ten countries in the world in terms of research and development, including through the creation of an effective system of higher education	Total financial support of the project: education — 810 billion rubles; science and universities — 562 billion rubles
2021	Priority 2030 Program (Order of the Government of the Russian Federation of May 13, 2021, No. 729 "On Measures to Implement the Priority 2030 Strategic Academic Leadership Program")	Support for university development programs and assistance in increasing the contribution of Russian universities to the achievement of the national development goals of the Russian Federation for the period up to 2030	Financial support for the project as part of the National Project "Science and Universities"

Source: compiled by the authors.

teams, open collection of proposals, stage-by-stage examination of strategic developments, discussion platforms, "live" research laboratories, and joint projects, permanent digital analytical platforms that support all stages of development and implementation.

At the meso-level, the content of the strategic development of science and education is supplemented by the following guidelines:

- Implementation of the ecosystem approach to the development of the scientific and educational spheres, which involves building close ties between universities and regional authorities for a joint coordinated solution of a whole range of tasks, ranging from a territorial and sectoral adaptation of the target orientation of the development of science and production and educational centers, removal of barriers to the implementation of regional development projects, comprehensive economic, legal and organizational support for macro-regional programs and projects.
- Transition to "smart" integrated territorial and sectoral planning in the space of the new economy with an extended time horizon of coverage, which involves the creation of modern infrastructures in regional ecosystems for the sustainable development of enterprises and organizations and end-to-end mechanisms in the system of relations "human — education — employment — living standards" aimed at reducing all types of inequality and improving the well-being of the population. The subjects of the sphere of science and education in this case are not just connected to this process, but play the role of initiators, drivers and integrators.
- Development of regional strategies for the development of science and education, which determine the content of the transformation of this area, firstly, as a major employer (about 8% of graduates become teachers, 8–10% ensure the reproduction of scientific personnel); secondly, as suppliers of personnel for the new economy; thirdly, as a source of scientific and technological solutions for the territorial and sectoral development of the innovation economy and the knowledge economy.
- Creation of centers of concentrated growth based on the activation of talent management, subject to overcoming digital and educational inequality by searching for mechanisms to increase the overall minimum level of education with the involvement of schools, secondary vocational education institutions, universities and regional government entities, increasing the proportion of graduates with a higher level of education in their total number.
- Economic, social and legal support of digital platforms for testing and maintaining knowledge bases.

The lack of funding to ensure the transfer of scientific ideas and developments from universities to industry is a serious obstacle to the effective commercialization of university technologies.

At the micro-level, the strategic content of the development of scientific, scientific, educational and educational organizations in the proposed content framework is associated with the creation of professional communities corresponding to new tasks and goals (in the format of an ecosystem) and full immersion in the mechanisms of digitalization of the economy, both in terms of training personnel for the digital economy, and in the development of scientific, technological, organizational and managerial solutions for the systemic transformation of the Russian economy, as well as in the promotion and popularization of all implemented state super services that allow the use of digital platforms to support the needs of society and improve the living standards.

DEVELOPMENT OF FINANCIAL INSTRUMENTS IN THE FIELD OF SCIENCE AND EDUCATION TO ENSURE THE TRANSFORMATION OF THE RUSSIAN ECONOMY

Financial instruments are a fairly effective mechanism for achieving results if it is necessary to transform the Russian economy in accordance with the given principles. Thus, in order to achieve strategic goals in the field of science and education over the past 20 years, a number of financial mechanisms have been implemented in the Russian Federation and continue to be implemented at the present time, presented in *Table 3*.

The development of the transfer of scientific and educational technologies requires the constant development of economic, financial and legal instruments that accompany their promotion in the form of removing barriers and identifying risks, which makes it possible to form a management decision-making system based on financial and economic indicators.

Financial support for the strategic development of science and higher education in Russia is planned as part of, among other things, the Priority 2030 program, the main goal of which is to support university development programs and promote an increase in the contribution of Russian universities to the achievement of the national development goals of the Russian Federation for the period up to 2030, balanced spatial development of the country, ensuring the availability of high-quality higher education in the constituent entities of the Russian Federation.[9] Three basic products of universities are identified that underlie those effects that are primarily embodied in students and graduates as active elements that change society, which the state, society and the economy can expect from higher education: scientific knowledge; development of human capital; technology and innovation.

Another financial instrument of the emerging mechanism for transforming the achievement of indicators of the strategic development of science and education through the development of the Priority 2030 Program is closely related to the national development priorities of the country, reflected in the Decree and instructions of the President of the Russian Federation,[10] national projects,[11] the Strategy for scientific and technological development,,[12] spatial development,[13] socio-economic development[14] and involves a minimum grant of 100 million rubles annually. It is also expected to co-finance activities through income-generating activities in the planned 10-year period, which will attract industrial partners, regional companies, etc. to the implementation of the relevant tasks.

RESULTS AND CONCLUSIONS

Thus, the study allows us to draw several interrelated conclusions. First of all, the instruments of financial support for the development of science and education in Russia should be linked to the content of development strategies for these areas at different levels of the economic hierarchy and built into more general economic mechanisms. To ensure not only short-term results but also long-term positive effects of the development of science and education, it is necessary to implement an ecosystem approach. This will bring

[9] Order of the Government of the Russian Federation of May 13, 2021, No. 729 "On Measures to Implement the Program of Strategic Academic Leadership "Priority 2030".

[10] Decree of the President of the Russian Federation of July 21, 2020, No. 474 "On the National Development Goals of the Russian Federation for the Period up to 2030".

[11] National Project "Science and Universities". Federal project "Personnel for the Digital Economy" of the national program "Digital Economy of the Russian Federation".

[12] Decree of the President of the Russian Federation of December 1, 2016, No. 642 "On the Strategy of Scientific and Technological Development of the Russian Federation".

[13] Order of the Government of the Russian Federation of February 13, 2019, No. 207-r.

[14] Strategies for socio-economic development of the relevant regions of the Russian Federation and sectoral documents of strategic planning of the Russian Federation.

together partnerships and resource flows of all stakeholders, ensuring their mutually coordinated activities within a common ecosystem. Only with a balance of private and public funding, and full-scale multi-channel co-financing for the development of science and education, it is possible to achieve significant long-term effects in the area under study. The ecosystem approach in this case allows not only to accumulate large resources but also to more reasonably choose investment objects and use financial resources efficiently. It is advisable to rely on financing instruments that have proven their effectiveness, can be successfully replicated, have a self-reproducing nature and allow the introduction of new approaches to the formation of the science economy. This opens up new areas of research related to the development of methodology and methodological tools that allow not only legal support for the creation and transfer of new scientific results but also to evaluate their economic efficiency.

The combination on the platform of economic mechanisms of various financial instruments that have powerful stimulating, and not just providing potential, allows for regulating the development of science and education by balancing the volumes, methods, and conditions for the provision of financial resources, taking into account territorial and sectoral factors, features of the development of specific scientific and educational institutions. All of this makes it possible to track long-term trends in the development of the economy, meet the current needs of science and education, and predict and design the future development of universities.

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M. A. Borovskaya — defined the problem and the objectives of the study, developed the logic and wrote the conclusions of the research.
A. Yu. Nikitaeva — developed the conceptual framework of the study, analyzed the literature, described the results.
M. R. Bechvaya — performed the critical analysis of programs and projects, analyzed the legal acts, compiled the tables.
O. A. Chernichenko — collected statistical data, developed a tabular presentation of the results.

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