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Barriers to the Formation of an Ecosystem of Technological Entrepreneurship in Russia

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ABSTRACT

The article is devoted to the current issues of the development of the technological entrepreneurship ecosystem, the growing importance of which is due to the need to implement innovative high-tech business ideas, their implementation and iteration to achieve Russia's technological sovereignty. The **purpose** of this study is to generalize and evaluate Russian experience of state support for technological entrepreneurship, as well as to identify barriers to the formation of an innovation ecosystem at the regional level. During the research process, a complex of general scientific **methods** was used, including: analysis and synthesis, logical, monographic, questioning, generalization, interpretation, graphic visualization. The continuity of international practice of innovative development for Russia, especially in the context of promoting the development of the technological entrepreneurship sector, is determined in the plane of the formation of an innovative society, mental and cognitive strengthening of the national innovation ecosystem. An analysis of the key imperatives in terms of institutional, financial, economic and program mechanisms for supporting the Russian high-tech sector and entrepreneurship was carried out. Based on the results of a survey of subjects of the innovation process conducted as part of thematic foresight sessions in the period 2019–2023. in the regions of the Volga and Ural Federal Districts, barriers limiting the development of the technological entrepreneurship ecosystem are identified, and development directions that help improve its efficiency are identified. From the point of view of practical significance, the results of the study can be useful to government authorities at all levels in the implementation of ecosystem management decisions, including the development of tools to support individual sectors of the economy, the preparation of road maps, regional strategies and standards in the field of innovative development.

Keywords: technological entrepreneurship; ecosystem; innovations; scientific and technological development; technological sovereignty; public policy; regional development

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INTRODUCTION

The growing role of new technologies in the achievement of global leadership by individual countries and regions increases the importance of technological entrepreneurship as an element of national innovation ecosystems — its contribution to the global economy currently exceeds 30% of global GDP.[1] Against the backdrop of the current geopolitical crisis, characterised by unbalanced international economic relations, reformatting of financial mechanisms, and toughening of sanctions policy, innovative development of countries will be focused on domestic sources of growth.

Technological entrepreneurship promotes breakthrough innovations that provide unique offerings and long-term competitive advantages, and its specificity is determined by the following aspects:

- new knowledge and technologies facilitate the penetration of knowledge-intensive solutions into various spheres of life, "socialising" progress;
- technological enterprises (start-ups) generate innovations and integrate resource potential in collaborative partnerships;
- market niches of potential innovative growth are being developed to utilise financial, intellectual, and other types of assets.

The need to strategise innovative changes due to the demands of the neo-industrial agenda (especially in terms of achieving Russia's technological sovereignty) actualises the study of various approaches to the formation and development of the technological entrepreneurship ecosystem at the federal and regional levels.

The theoretical and methodological basis of this study is the provisions of a number of theories: ecosystem, state regulation of the economy, technological patterns, network and spatial economy, firms, and innovation. The application of the ecosystem approach in the economy at the present stage contributes to the qualitative transformation of interaction models of actors — participants of innovation processes — and to the improvement of their economic efficiency.

A significant contribution to the formation and development of the ecosystem concept was made by representatives of foreign and Russian scientific schools: J.F. Moore, M.J. Jacobides, A. Haver, A.V. Babkin, G.B. Kleiner, Yu.A. Kovalchuk, T.O. Tolstykh, N.V. Shmeleva, L.A. Gamidullaeva, V.A. Karpinskaya and others, whose works cover conceptual and methodological aspects of ecosystem development in territorial, sectoral, industrial, and subject contexts [1–6].

Among the most significant researchers of entrepreneurship and, in particular, its technological type, we should mention I. Schumpeter, P. Drucker, G. Etkovits, M.A. Curry, etc. [7–10].

Most modern foreign scientific works confirm the hypothesis about the positive impact of technological entrepreneurship on the economic development of countries and regions [11–14], while the analysis of the Russian publication section shows a significant increase in research interest in fundamental and applied issues of entrepreneurship development in the field of technology. Thus, S.P. Zemtsov notes that against the background of natural, technological, restrictive, and other risks that undermine the foundations of the raw material growth model, due to the ability to change and adaptability, it is technological entrepreneurs who can become the agents of change in the new economy [15]. The study by I.V. Korchagina and K.V. Rogova emphasises the influence of innovation culture, social capital, coevolutionary processes on the emergence and growth of technology companies, and points

[1] Global Entrepreneurship Monitor 2021–2022. URL: https://www.gemconsortium.org/report/gem-20212022-global-report-opportunity-amid-disruption (accessed on 14.07.2023).

to the need to maintain sustainable dynamics of interaction in innovation ecosystems [16]. The study by N.G. Kurakova and L.A. Tsvetkova, which highlights the importance of the ecosystem approach in the institutional transformation of educational organisations, is devoted to the factors of inhibition and acceleration of the development of technological entrepreneurship in regional universities in Russia [17]. R. Malikov, K. Grishin, D. Sultangareev conclude that each entrepreneurial ecosystem is characterised by a specific regional context associated with the differentiation of the potentials of emergence, discovery, and exploitation of entrepreneurial opportunities [18].

TECHNOLOGICAL ENTREPRENEURSHIP IN RUSSIA: IMPERATIVES FOR DEVELOPMENT

By the end of the 2000s, the Russian economy had significantly increased the structural imbalance characterised by the dominance of the primary sector of the economy, exhaustion of sectoral advantages and growing technological lag in advanced production areas. The impact on the domestic economy of the anti-Russian sanctions imposed since 2014 required significant efforts of the management system to maintain critical sectors of technological support of industry. During this period, the need to overcome the gap between science and production, as well as the development of new effective institutional, financial, and economic mechanisms to promptly overcome the dependence on imported technologies and ensure innovative growth became acute.

In 2016, the Strategy for Scientific and Technological Development of the Russian Federation (hereinafter — the Strategy) was approved, the goal of which is to "ensure the country's independence and competitiveness by creating an effective system for building up and utilising the nation's intellectual potential".[2] In pursuance of the Strategy, the Russian Government initiated the National Technology Initiative (NTI),— a long-term interdepartmental programme to create conditions for Russian enterprises to become leaders in high-tech markets by 2035.[3] It was relaunched in 2020 on the basis of a renewed vision of its ecosystem. The National Technology Initiative is specific in that the list of measures required to achieve the set goals and the logic of the strategy are formulated directly by high-tech business, while the government plays the role of a service partner. The 12 working groups of the programme consist of representatives of the executive branch, business and scientific and educational sectors, jointly working on 9 promising markets (aeronet, autonet, marinet, neuronet, foodnet, healthnet, energinet, safenet, and other markets).

Over the 7 years of the National Technology Initiative operation, more than 40 federal-level regulations have been initiated and adopted in favour of technological entrepreneurship, and more than 50 new technologies and products have been developed, including an ultra-high-frequency modulator for 6G-system components; a power system for smart energy management; a GLONASS platform for collecting big data from road networks; a processor for studying neural networks; hybrid unmanned systems for working in extreme climatic conditions; the first Russian electric car based on digital twin technology; Agro-National Technology Initiative project for digitalisation of agriculture; etc.

New formats include infrastructure centres, National Technology Initiative 2035 university and master's programme, boiling points, quantoriums and club movement, project and educational intensive "National Technology Initia-

[2] Decree of the President of the Russian Federation of 01.12.2016 No. 642 "On the Strategy for Scientific and Technological Development of the Russian Federation". URL: http://government.ru/docs/all/109256/ (accessed on 18.06.2023).

[3] The National Technology Initiative (official website). URL: https://nti2035.ru/ (accessed on 19.06.2023).

tive Archipelago", technological competitions, Leader-ID information, and service resource, which are, in fact, "closing" for innovative actors. As for project financing, the programme provides for the possibility of attracting extrabudgetary funds — their total amount was over 28 billion roubles; according to the National Technology Initiative platform, in 2016–2020, the share of third-party investments exceeded 44% of total R&D investments.

In April 2023, the National Technology Initiative Sovereign Technology Fund was established, through which 20 projects with investments of RUB 6.4 billion are to be implemented by 2029 in the field of unmanned aerial vehicles, micro- and radio electronics, and wireless communication technologies. According to the organisers, in the absence of current projects on critical technologies, the Fund intends to invest in the relocation of engineering and nurture its own scientific and technological school.[4]

Basic R&D support tools have been systematically operating in the country since 2019. They provide subsidies to compensate part of the costs of research in modern technological areas (up to 70% of the costs). In 2022, RUR 15 billion was allocated for R&D subsidies. At present, the state is particularly interested in "fast" R&D (no more than 1 year) in order to obtain ready-to-produce competitive technological products in the shortest possible time. Each national project developed by the Government of the Russian Federation in 12 strategic development areas contains an innovation component formalised as a separate project vector or implementation tool.

To promote the development of high-tech industries, a number of state programmes were adopted: "Development of Electronic and Radioelectronic Industry", "Information Society", "Development of Aviation Industry", "Digitalisation of Industry", "National Software Import Substitution Programme", etc., the implementation of which is supervised by relevant departments and state corporations (State Company "Rostech", State Company "Rosatom", Russian Corporation of Nanotechnologies, etc.).

The mechanism of special investment contracts (SPIC 1.0 and SPIC 2.0), developed by the Ministry of Industry and Trade of the Russian Federation under the import substitution programme in 2015 and modernised in 2019, provides for joint participation of the state and investors in the implementation of major innovation projects in the interests of a promising technological agenda. The parties to the SPIC undertake obligations to improve the technological level of production and receive a number of advantages: tax and regulatory benefits, industry subsidies, privileged status in public procurement depending on the size of investments, compensation of R&D costs, preferential lending, and guarantees of unchanged business conditions [19]. As of the beginning of 2023, 68 SPICs have been concluded. According to the public register, most of the contracts are implemented in the automotive industry — 16, chemical industry — 15 and pharmaceuticals — 11. The total volume of project investments exceeded RUB 977 billion.[5]

Russia's innovation infrastructure was formed in accordance with government programmes, including: "Support Programme for Pilot Innovative Territorial Clusters" (2013–2015), "Industrial Parks" (2014–2017), "Establishment of Technoparks in High Technology in the Russian Federation" (2007–2015) and others. For the purpose of import substitution in the period 2015–2021, the government financed projects totalling over

[4] NTI Sovereign Technology Fund. URL: https://www.tadviser.ru/index.php/Компания: Фонд_суверенных_технологий_НТИ_(ФСТ_НТИ) (accessed on 21.06.2023).

[5] Investment projects and SPICs concluded. URL: https://minpromtorg.gov.ru/activities/vgpp/vgpp2/done/ (accessed on 24.06.2023).

RUB 3 trillion (direct budget financing totalled RUB 500 billion).[6]

In the context of financial support, a system of development institutions is connected to the activities of technological entrepreneurship, including: The Foundation for Assistance to Small Innovative Enterprises in Science and Technology (FAI), "Rusnano", "Skolkovo" Foundation, "VEB Innovations", "Russian Venture Company", "Agency for Strategic Initiatives", and others. These structures help innovative start-ups at various stages of financing, preferential lending, and project support: administrative, informational, consulting, educational, and property support. About 60% of all support is provided by the Foundation for Assistance to Small Innovative Enterprises in Science and Technology. For example, in 2022, RUR 7 billion was allocated for the creation and modernisation of 250 high-tech small and medium-sized enterprises (SMEs). Up to RUB 30 million can be received for the launch of innovative production, provided that the R&D stage is completed. Over 5 years, more than RUR 20 billion was allocated to support projects in aggregate; the increase in revenue of innovative products due to grants over this period totalled RUR 140 billion.[7] According to the Foundation for Assistance to Small Innovative Enterprises in Science and Technology, the demand for this form increased 1.5 times in 2023.

In 2022, the Russian government approved the rules of preferential lending for high-tech SMEs — the rate for investment purposes and working capital replenishment for up to 3 years is 3%. RUB 4 billion will be allocated for budget subsidies for the programme over the next three years.[8]

As part of the implementation of the priority action plan to ensure economic development under external sanctions pressure, special attention was paid to the IT sector, which received RUB 21.5 billion in 2022, including RUB 14 billion — in the form of grants. This amount covers 80% of the cost of projects of IT companies developing software (previously — no more than 50%). The software sector became the leader in terms of the number of venture deals in 2022, which is due to the sharply increased interest in IT security on the part of Russian companies due to the withdrawal of foreign developers from the country.

In 2022, a mortgage mechanism was launched for the purchase of industrial real estate (industrial mortgage)[9] — a preferential loan for the purchase of industrial space and the rapid launch of projects, and later — for the construction of new facilities, as well as the reconstruction and overhaul of existing ones. For technology companies, the interest rate is 3% for a term of up to 7 years with the loan amount not exceeding RUB 500 million.

In addition, in 2022, programmes to stimulate technological entrepreneurship on the basis of educational institutions were launched, in particular, such federal projects as "Advanced Engineering Schools", "Creation of a Network of Modern Campuses", "University Technological Entrepreneurship Platform" — the latter is expected to result in 30 thousand technology entrepreneurs entering the market

[6] State support for import substitution: programmes, subsidies, and tools to help industrial companies. URL: https://delprof.ru/press-center/open-analytics/gosudarstvennaya-podderzhka-i / (accessed on 19.06.2023).

[7] The Foundation for Assistance to Small Innovative Enterprises in Science and Technology. URL: https://sfr.gov.ru/press_center/z_news/~2023/01/05/244129 (accessed on 18.06.2023).

[8] Resolution of the Government of the Russian Federation No. 469 dated 25.03.2022 "On Approval of the Rules for Granting Subsidies to JSC "Russian SME Support Bank" for Reimbursement of Income on Loans Granted in 2022–2024 to High-Tech, Innovative SMEs at a Preferential Rate". URL: http://publication.pravo.gov.ru/Document/View/0001202203280014 (accessed on 19.06.2023).

[9] Resolution of the Government of the Russian Federation of 06.09.2022 No. 1570. URL: http://government.ru/docs/all/143173/ (accessed on 20.06.2023).

by 2030. According to the results of the first year of project implementation, 30 advanced engineering schools were established in Russian universities in 15 regions of the Russian Federation.[10] A total of 15 startup studios, 60 entrepreneurial "boiling points" were launched across the country, 300 training sessions and 151 accelerator programmes were developed, which have already been attended by more than 30,000 people. More than 1,000 students received grant support in the amount of RUB 1 million.[11]

In May 2023, the Russian Government approved the Concept of Technological Development until 2030,— a list of the main mechanisms for achieving technological sovereignty, with the following targets: reduction of Russia's technological dependency ratio by 2.5 times; increase in patent activity by 3 times; and growth rate of innovative products — by 1.9 times.[12] 10 cross-cutting technologies and 8 areas of industrial development were selected based on the submissions of agencies. One of the conditions for successful implementation of the Concept's provisions is a high level of innovation activity of the business sector.

PROBLEMATICS OF TECHNOLOGICAL ENTREPRENEURSHIP DEVELOPMENT: CONSTRAINING FACTORS

Assessing the level of development of technological entrepreneurship in Russia, it should be stated that, despite the complex of projects and programmes implemented by the state, it is currently insufficient to ensure technological sovereignty for a number of reasons:

1. Government investments prevail in the structure of science and technology financing, while the share of the entrepreneurial sector remains relatively low — over the last ten years it did not exceed 14–16 per cent of domestic R&D expenditures (*Table 1*) and tended to decline.

R&D expenditures amount to 1.0% of GDP (their planned values, according to the national project "Science", do not exceed 1.2%). At the same time, the leading countries in the field of technology — China, Japan, Germany — allocate up to 2.5–3 per cent of GDP to science (with the share of private R&D funding reaching 60–80 per cent). Speaking about motivational aspects of entrepreneurial activity, it should be noted that there is a shortage of own funds for the development of innovative solutions; insufficient state support for R&D; lack of highly qualified personnel, high competition with foreign manufacturers and the habit to focus on borrowing technologies.

2. The main goals, priorities and directions of the country's innovative development were stated in the Strategy for Innovative Development of the Russian Federation until 2020 approved by the Government of the Russian Federation.[13] The analysis of the dynamics of indicators of enterprises in the innovation sector of the Russian economy shows that the key target indicators outlined in this document were mostly not achieved (*Table 2*). Thus, the increase in the share of innovative goods in the total volume of industrial production by 2020 did not exceed 1.5% (against the expected 20%). The level of innovation activity of organisations in industry increased to 16.2% (instead of the planned 60%).

The share of innovative goods (types of work, services) new to the market during the period under review remained practically unchanged and approached the expected value (8%) by only 0.1%. The balance of export-import of technologies has not left the zone of negative values for

[10] Advanced engineering schools (analytics). URL: https://analytics.engineers2030.ru/ (accessed on 11.06.2023).

[11] Federal project "University Technological Entrepreneurship Platform".URL: https://univertechpred.ru/ (accessed on 11.06.2023).

[12] Concept of Technological Development of Russia until 2030. URL: https://ngtpp.ru/wp-content/uploads/2023/02/Kontseptsiya-tehnologicheskogo-razvitiya-na-period-do-2030-goda.pdf (accessed on 25.06.2023).

[13] Strategy for Innovative Development of the Russian Federation until 2020. URL: http://government.ru/docs/9282/ (accessed on 14.07.2023).

Table 1

Structure of domestic R&D costs in the Russian Federation by sources of funding, %

Source of financing	2000	2010	2019	2020	2021
Budgetary funds	53,7	68,8	64,4	65,4	64,6
Own funds of scientific organisations	9,0	9,1	17,0	17,5	18,7
Funds of the business sector	18,6	16,4	14,9	13,8	13,6
Funds of innovation support funds	-	-	1,1	1,2	1,0
Funds from foreign sources	11,9	3,6	2,4	1,8	1,9
Funds from other sources	0,17	0,2	0,2	0,3	0,2

Source: compiled by the authors based on Rosstat data. URL: https://rosstat.gov.ru/folder/210/document/12994

ten years. There was an obvious growth in the number of industrial organisations engaged in technological innovations, both among the total number of enterprises and within them (by 3 times and 2.3 times, respectively).

With regard to the share of innovative goods new to the world market, the planned level was achieved and amounted to 0.3% in 2020. It should be stated that despite the positive dynamics of some indicators, the national innovation system has not developed intensively enough in recent years.

3. According to the Global Innovation Index (GII) rating, Russia ranks 47th in the world in terms of innovation development in 2022 (45th — in 2021). Positive dynamics is observed in a number of index components, including the level of domestic market development (+13 p.p.), the effectiveness of creative activity (+8 p.p.), the level of human capital development (+2 p.p.) However, the country's innovation potential is only 61% utilised. The GII data also characterise the insufficient maturity of the institutional infrastructure and legislation in the innovation sphere.[14]

4. The National Report on Innovations in Russia for 2020 notes that the level of their commercialisation remains at a low level, which significantly limits innovative development.[15] The coefficient of inventive activity in the last 5 years shows a downward trend (in 2018–2.33; in 2022–1.87).[16] According to Rospatent, the number of applications by Russians for inventions and utility models in 2021–2022 decreased (by 3.1 and 5.69%, respectively). Significantly greater decrease in patent activity was observed from foreign applicants. Thus, there were 30.3% fewer applications for inventions and 25.7% fewer applications for utility models.[17]

5. Underdevelopment of the venture capital market, aggravated by its practical collapse by the end of 2022. The level of investments decreased across all market players (see Figure). The decline amounted to 68% as compared to the previous period, the number of deals on investment in start-ups decreased to the minimum level for the past 7 years

[14] Global Innovation Index 2022. URL: https://www.globalinnovationindex.org/Home (accessed on 15.07.2023).

[15] National Report on Innovation in Russia 2020. URL: https://obrazovanie-gid.ru/doklady/nacionalnyj-doklad-ob-innovaciyah-v-rossii-2020.html (accessed on 15.07.2023).

[16] Inventive activity coefficient in the regions of the Russian Federation 2023. URL: https://new.fips.ru/about/deyatelnost/sotrudnichestvo-s-regionami-rossii/a-iz-akt-2022.pdf (accessed on 16.07.2023).

[17] Rospatent. Key performance indicators of Rospatent for 2022. URL: https://rospatent.gov.ru/ru/about/stat/osnovnye-pokazateli-2022 (accessed on 16.07.2023).

Table 2

Dynamics of indicators of innovative development of the Russian Federation in 2010–2020

Index	2010	2015	2016	2017	2018	2019	2020 Plan for SID RF*	2020 Fact
R&D expenditure, in % of GDP	1,13	1,10	1,10	1,11	1,00	1,04	3,0	1,1
Share of innovative goods in total industrial output, %	4,9	7,9	8,4	6,7	6,0	6,1	25	6,4
Share of organisations engaged in technological innovation in the total number of organisations, %	7,9	8,3	7,3	20,8	19,8	21,6	25	23
Share of organisations implementing technological innovations in industry, %	9,4	7,9	9,2	19,6	18,5	20,0	40	21,5
Share of innovative goods, types of work, services, new for the sales market of organisations, %	0,8	0,9	1,0	0,9	0,9	0,6	8	0,9
Share of innovative goods new for the world market, %	0,03	0,3	0,1	0,2	0,2	0,3	0,28	0,3
Level of innovation activity of organisations, %	9,5	9,3	8,4	14,6	12,8	9,1	-	10,8
Level of innovation activity of organisations in industry, %	11,0	10,6	10,5	10,6	15,6	15,1	60	16,2
Balance of export-import of technologies, USD mln.	- 1	- 0,6	-1,2	-2,1	-1,7	-1,3	0,3	-0,2

Source: compiled by the authors based on Rosstat data. URL: https://rosstat.gov.ru/statistics/science/

Note: * – target indicators in the Strategy for Innovative Development of the Russian Federation.

(139 vs. 306 in 2021). For 2023, the market is forecast to shrink further (from USD 819 million to USD 400 million).[18] The main factor behind the negative trend is Russia's involvement in the geopolitical conflict. Market players are likely to remain cautious until the conflict is over. While individual investors try to identify and acquire quality assets during the crisis, opening up new growth opportunities, corporations tend to take a wait-and-see attitude.

6. Inefficiency of innovative development institutions, which necessitated their reform against the background of severe criticism of their activities. According to the Federal Treasury, in the period 2006–2020, about RUR 1 trillion of budget funds were allocated to these organisations.

[18] Investment in Russian start-ups may be at a record low in 2023. URL: https://www.forbes.ru/svoi-biznes/486532-investicii-v-startapy-v-rossii-mogut-okazat-sa-rekordno-nizkimi-v-2023-godu (accessed on 15.07.2023).

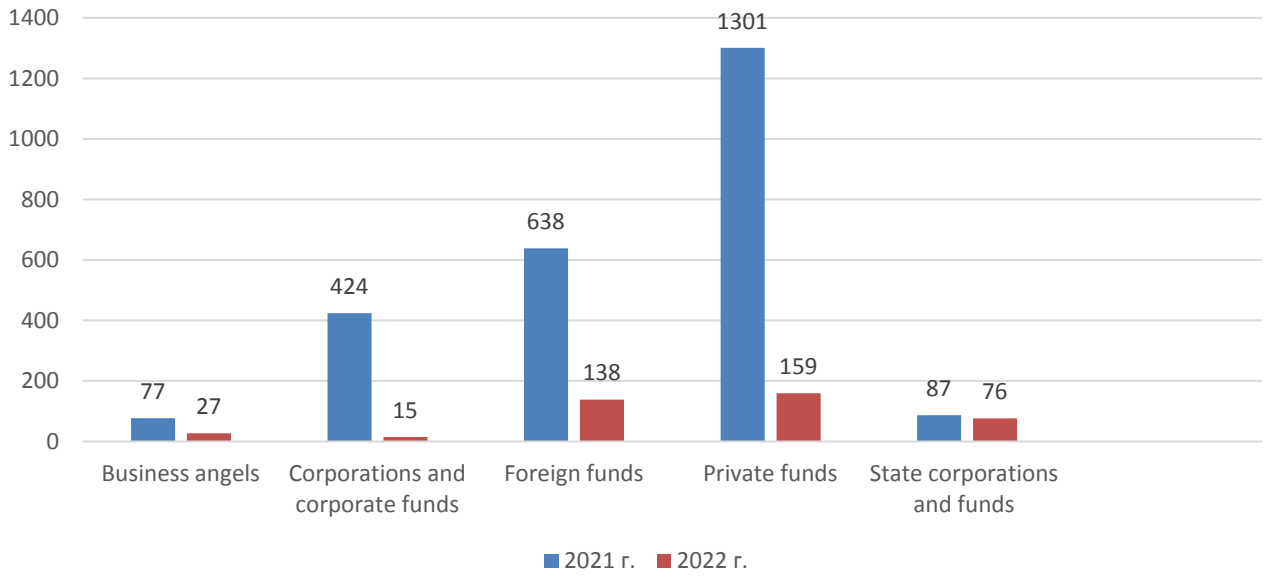

Fig. **Venture financing in Russia in 2021–2022, million dollars**

Source: compiled according to the analytical study "Venture Eurasia 2022". URL: https://dsight.ru/

At the same time, the dynamics of innovative products output over the period of their operation is insignificant, as well as the demand in the world market for the products of the companies they invested in [20].

The number of development institutions has been optimised, but their investment opportunities remain rather modest (their share in total domestic R&D expenditures does not exceed 1–2%). According to the audit conducted by the Accounts Chamber of the Russian Federation, these institutions, created to stimulate innovation and support technological entrepreneurship, have so far failed to show the expected level of efficiency.19 At the same time, it should be acknowledged that, as a result of the revision of their number and organisational modernisation, both the level of project management and the transparency of the selection of the latter for grant support have improved.

7. Negative assessments of the investment climate in Russia and macroeconomic risks contributed both to the suspension of international cooperation in most technological areas, as well as the termination of joint research programmes and restricted access to technological solutions and services necessary for scientific work. Leaving the Russian market, manufacturers of high-tech products temporarily or completely stopped the activities of specialised centres in the country. This process was accompanied, among other things, by the relocation of personnel. The volume of foreign investment in the Russian innovation sphere through research programmes has decreased over the past twenty years from 11.9% to 1.9% (*Table 3*).

A systemic increase in entrepreneurial activity in this area will require a number of regulatory, administrative and organisational solutions, removal of barriers and creation of the most favourable production opportunities in the technology sector.

In the context of international continuity, Russia is interested in the experience of technological entrepreneurship development in the countries that are its most important strategic partners — China and India, where the emphasis was placed on the formation of an innova-

[19] The Accounts Chamber stated that innovative development institutions are unprofitable. URL: https://www.banki.ru/news/lenta/?id=10964017 (accessed on 17.07.2023).

tive society as the basis for the growth of the innovation economy [21, 22]. This allowed to achieve significant results in the frontier areas of global technological development. This approach stipulates not only the construction of the national innovation ecosystem, but also its mental and cognitive strengthening through a comprehensive management impact of the state, aimed at improving systemic sustainability and performance.

REGIONAL ASPECT OF TECHNOLOGICAL ENTREPRENEURSHIP ECOSYSTEM DEVELOPMENT

At the present stage, the processes of development of regional innovation ecosystems in Russia are characterised by the lack of a comprehensive methodology due to the high level of existing spatial polarisation, peculiarities of historical development and local technological specialisation. Interregional differentiation and increasing concentration of innovation activity in the largest agglomerations and leading regions (Moscow, St. Petersburg, Moscow, Nizhny Novgorod, Sverdlovsk, Novosibirsk, Samara, Tomsk Regions, Perm Territory, Republic of Tatarstan) contribute to significant differences both in the volume of its support by the state and in the level of involvement of business entities in the science and technology sphere.

The development of the technology entrepreneurship ecosystem in the regional context is aimed at creating innovative products, commercialising the scientific field and scaling local businesses, which, in turn, will contribute to the growth of revenue of high-tech industries and their share in GRP, increase tax revenues, stimulate exports and ensure the entry of technology companies in IPOs (share issue).

Regional standards of the National Technology Initiative, which are methodological tools for economic development through innovative projects in Russian regions, are being implemented in the Novosibirsk, Samara, Tyumen, Ulyanovsk, Kaluga, and Chelyabinsk Regions. Roadmaps for the development of the technological entrepreneurship ecosystem are currently developed in Moscow, St. Petersburg, Perm and Primorsky Territory, and Pskov Region. In 2023, the authorities of the Republic of Tatarstan and a number of other regions announced the need for action in this direction.

To assess the current situation, as well as to elaborate the prospects and ways of development, the authors of the article conducted a foresight study at the regional level to identify the barriers to achieving the indicators of development of the technological entrepreneurship ecosystem, consisting of the following stages 20 [23]:

1. Formation of the research programme by the working group (definition of the concept, goals and objectives, choice of methods).

2. Creation of an expert group (12 people) to work on the given topic using information and analytical materials, working out the programme context on the basis of the principles of involvement, communication, coordination and systematic. When selecting the experts (representatives of scientific organisations, universities, expert councils of executive regional authorities), we took into account the levels of education and competences in the field of activity, experience of expert work.

3. The expert group will form a pool of indicators for the development of the technology entrepreneurship ecosystem, including: the number of technology companies in the region and the number of their personnel; the number of startups registered annually and the percentage of their "survival" in the market; the volume of non-state investments attracted to innovation projects; the participation of glob-

[20] Foresight is a technology of strategic management based on coordination of positions and interests of strategic influence groups regarding a set of factors, priorities and trends of development of systems, spheres, sectors, industries.

Table 3

Barriers to achieving development indicators for the ecosystem of technological entrepreneurship

Barriers	Share of survey participants who noted the barrier, %
"Toxicity" of state funding: excessive requirements for access to support	15
Non-synchronisation of goal-setting: National Technology Initiative is oriented towards 2035, regional authorities — towards the horizon of changing priorities, entrepreneurs — towards resource availability	12
Historical lack of entrepreneurial thinking	8
Lack of leaders capable of forming a positive public opinion	8
Lack of instruments of real influence	11
Unformed or closed technological demands	8
Lack of staff for qualified project support	8
Rigid regulations and standards	4
Unwillingness of entrepreneurs to invest in R&D	4
Imperfections in the current system of support for innovation activities	2
Lack of systemic interaction between industrial partners and the scientific and educational sector	6
Lack of venture funds with corporate participation at the regional level	4
Lack of access to decision makers	4
Current innovative development programmes are not included in decision-makers' KPIs	2
Mental gap between actors involved and not involved in the National Technology Initiative programme	4
Total:	100

Source: compiled according to the author's research.

al technology leaders in regional events; the number of well-known regional brands; the technological positioning of the region at the national and global levels.

4. Formation of a questionnaire containing a list of situational, open-ended, factual statements (judgements) of non-question form, fixing the essential characteristics of barriers to the development of the technological entrepreneurship ecosystem, and suggesting respondents to choose an option from the list given.

5. Conducting a survey of representatives of regional business, industrial sector, government agencies and development institutions within the framework of thematic foresight sessions on the prospects of technological entrepreneurship in the regions of the Urals and Volga Federal Districts (in the period 2019–2023).

6. Data processing, analysing the results.

The results show that the most significant barriers to achieving the set indicators of development of the technological entrepreneurship

ecosystem (as assessed by its subjects) are the "toxicity" of state funding, excessive requirements for access to support (noted by 15% of participants), as well as the non-synchrony of goal-setting of the participants of the innovation process in the technological sphere, since federal initiatives are focused on a long cycle (until 2035), regional authorities — on the horizon of changing priorities, and for entrepreneurs, of course, the primary factor is the factor of resource availability (12% of participants noted) (*Table 3*).

The "toxicity" of state or governmental funding can manifest itself in the establishment of control over businesses through the provision of support and subsequent pressure on them. The transfer of ownership of innovative solutions and commercialisation is often delayed for fear of overstepping the legal boundaries. Thus, companies decide to avoid interaction with the state, and in these cases the vector of technological entrepreneurship shifts towards large enterprises, which have much greater potential and opportunities to resist control and effectively balance in the innovation environment. In this case, the innovation market loses potential players, which negatively affects the pace of its development.

In addition, the excessive regulatory function of the state in relation to entrepreneurial ecosystems contributes to a decrease in the efficiency of the latter, as evidenced by a number of studies [24–26]. For example, direct support measures are often the reason for a decrease in productivity and competition, while the mechanism of public procurement often creates opportunities for corrupt practices.

Among the identified barriers we should also mention the lack of entrepreneurial thinking in the historical aspect of territorial development; lack of leaders with already existing positive experience in technology business, as well as qualified personnel for the implementation of projects; limited choice of real effective tools for influencing this sphere; lack of a clear idea of technological demands, the embodiment of which is possible on the basis of the potential of regional production systems.

The results obtained can be useful for the management system in terms of coordinating efforts aimed at working out the most problematic areas of technological entrepreneurship, as well as preparing measures within the framework of ecosystem solutions for roadmaps, strategies, and regional standards.

In order to overcome existing barriers and form an ecosystem of technological entrepreneurship at the regional level, including in the context of achieving technological sovereignty of Russia, it is necessary to ensure the following:

- creation of a favourable institutional environment and system support: sustainable cooperation with development institutions on regional programmes, improvement of legislation in the field of patent law, elimination of "toxicity" of state funding, development of standards for implementation of pilot projects and scaling of technological solutions;
- development of innovation infrastructure: venture funds, industrial parks and technoparks, business incubators, science and technology centres, etc.;
- increasing the level of involvement of the regional management system in the innovative neo-industrial agenda to ensure the interaction of actors: entrepreneurs, industrial partners, scientific and educational sector, development institutions;
- development of cases and justification of promising points of innovative growth for the regions, formation of a project portfolio for priority industries, markets, technologies, products; search for opportunities to scale regional projects up to the world level;
- implementation of accelerator programmes, use of new educational technologies that ensure the development of technological

culture and innovative thinking, attraction of innovatively active youth: creation of startup studios, profile classes, boiling points, club movement, system of expertise and mentoring;

- ensuring innovative demand, promoting multipliers of technologisation: innovation customers, anchor big business, technology entrepreneurs, highly qualified personnel of the technology sector;
- formation of a media plan to popularise technological entrepreneurship: coverage of technological exhibitions, publication of success stories of regional entrepreneurs, presentation of innovative projects at forums and conferences.

Thus, the objective reality indicates that the state strategy for the development of technological entrepreneurship should be built with a predominant reliance on internal sources.

CONCLUSIONS

The study allowed us to formulate the following main conclusions:

1. Russia has formed a holistic vision of innovation support and developed relevant institutions and mechanisms, which are updated by the governing system in accordance with the current situation. In addition, there is a clear understanding of the need to stimulate technological entrepreneurship due to the increasing role of technology in ensuring not only development processes, but also national security. At the same time, the performance of the domestic innovation ecosystem should be recognised as insufficient.

2. The dominance of the state in the innovation sphere of Russia under external pressure has played a definitely positive role, as the current support system has demonstrated its sustainability. At the same time, it is now necessary to improve both the efficiency and the level of managerial competences in the field of innovation regulation. In the conditions of increasing complexity and multitasking of ecosystem processes, effective strategising of innovative changes determines the development prospects of both individual regions and the country as a whole.

3. The most important solution at the present stage may be the expansion of the strategic goal from the formation of an innovative path of Russia's development to the creation of an innovative society as the basis of the economy. This will contribute to both mental and cognitive strengthening of the national innovation ecosystem as a whole, and a more comprehensive management approach to its key component — the ecosystem of technological entrepreneurship.

4. The study on identifying barriers to the development of the technological entrepreneurship ecosystem at the regional level revealed the problem of the negative impact of "over-regulation" of state support of the sector, as well as the lack of unity in the goal-setting of technological development for individual subjects of innovation activity. The elaboration of measures to levelling the existing barriers in general will contribute to the "self-identification" of regions in the national innovation ecosystem and the consistent achievement of strategic goals.

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