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Innovation Ecosystem as a New Form of Organizational Integrity and a Mechanism for Financing and Reproducing Innovations

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ABSTRACT

The subject of the study is the factors, models and processes of the emergence and development of modern innovation ecosystems (IES) that ensure the flow of assets, their transformation into innovations, and distribution across the territories of economic growth. **The purpose** of the paper is to identify the factors and trends in the development of the IES, based on the practices of individual States and driving forces of the world. **The methods** of sampling, grouping, comparison, analogy, analysis, generalization, system-structural approach to assessing the development of the subject of research are used. The result of the study was the definition of IES as an open institutional mechanism for the reproduction of innovations, transforming the competitive market environment in the direction of the dominance of stable intersectoral network structures. The decisive role of IES in the chain "national innovation strategy → (start-ups + companies + state institutions) → IES → [new start-ups + deep-tech companies unicorns (hectocorns) + new level of quality of the competitive environment] → global competitive advantage of the State" is established. On the example of China, the prospects of formation a model of the national IES, focused on long-term development, technological self-sufficiency of the State and, at the same time, providing the possibility of expansion to new markets, are proved. The authors see the prospects for further research of the IES in Russia in a shift of emphasis from the "banking" nature of the IES towards the formation of large territorial centers of the location of the IES while maintaining strong institutional support of the State.

Keywords: ecosystem; innovation; innovation ecosystem; institute; competitive advantages; inter-firm strategic alliance; cluster; complementary asset; start-up; unicorn company

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INTRODUCTION

Currently, there is a need for fundamentally new managerial and organizational approaches, tools, models to tap digital transformation of business subjects, to stimulate their innovative activity, to promote the initiation and implementation of technology creation, business process reengineering projects. Development of innovation and investment process from a linear model to modern self-organizing forms led to the formation of the concept of innovative ecosystem (further — IES). The collaboration, focused on simultaneous formation of horizontal and vertical network environment of communications between IES elements, ensures creation and multiplication of asset flows, their transformation into innovations, subsequent distribution across the territories of economic space, updating permanent scientific and applied research.

Problems of creation and development of IES were reflected in the paper of domestic and foreign researchers in agglomeration theory, network interaction, cluster concept. At the same time, setting a goal to identify the factors and tendencies of development of IES, following the practice of individual states and the driving forces of the world, the authors consider the application of research results as promising in reproduction of the advantages of the national innovation system, in developing the entrepreneurial potential of regions of the Russian Federation.

The methodology uses a three-stage approach. First, the views and concepts in the IES are analyzed. Second, the place of IES in the system of cluster-network structures was investigated, based on the synergistic principle of studying the ecosystem based on official statistics. Third, a detailed analysis of the institutional segments initiating and participating in IES in the context of domestic and foreign practice was conducted.

"INNOVATION ECOSYSTEM": TRANSFORMATION OF OPINIONS REGARDING CONTENT

The development of social networks and innovative business environment is accompanied by the formation of common perceptions and systems for the joint creation of economic values [1]. IES is considered by modern economic researchers as a new way of producing goods and services, taking different scales and configurations [2].

Among the first researchers, who applied the term "ecosystem" to the economic environment, was M. Rothschild in 1990, who determined the competitiveness of the organization in the network of customers, competitors, partners, suppliers, level of technology and innovation [3]. The IES concept presented for the first time by W. Wessner considers innovation as "the process of transforming an idea into a market product or service that requires synergy, and therefore — a lot of collective efforts of participants" [4].

In our view, the simplest definition of IES is declared by the National Science Foundation (NSF) under the US Government as "people, institutions, policies and resources that contribute to the transformation of new ideas into products, processes and services" [5].

"Innovation Ecosystem — network of private and public sector institutions, whose activities and relationships are aimed at initiating, importing, modifying and diffusing new technologies" (C. Freeman [6]). A similar position is presented in the papers of C. Edquist, which by IES means "all the significant factors that influence the formation, use and diffusion of innovation, singling out organizations that perform actions aimed at others and those who create rules of behavior" [7].

In the network innovation model of P. Gloor, community members form a specific ecosystem by entering into a relationship of collaboration [8, 9]. Thus, IES is based on

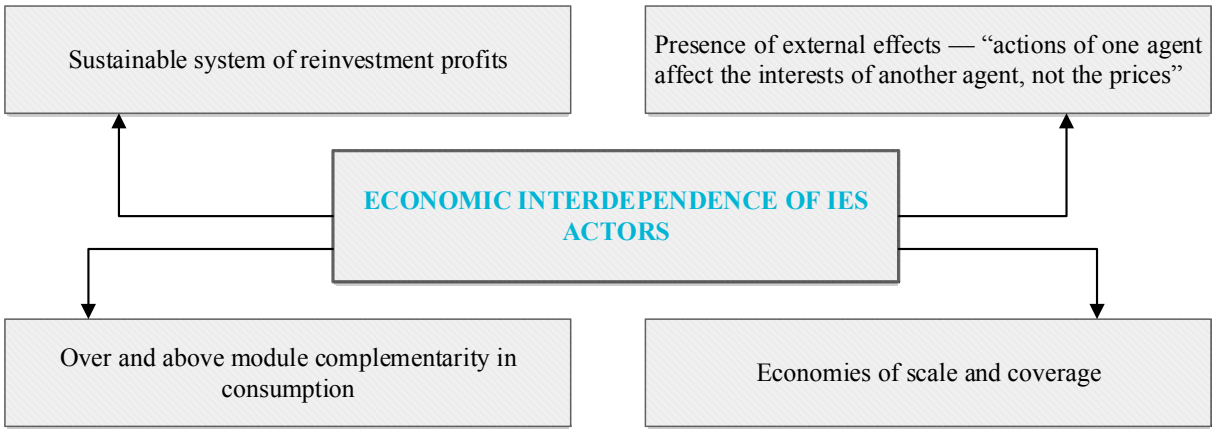

Fig. 1. **Manifestations of the Economic Interdependence of the Actors of the Innovation Ecosystem**

Source: Compiled by the authors.

certain institutions and a mechanism of joint institutionalization [10, 11].

A special client-centered context has a definition of IES by R. Adner as a cooperation mechanism by which firms combine their individual proposals into a coherent, customer-oriented whole [12]. According to Russian Venture Company terminology, "innovative ecosystem — is a set of subjects interacting in the process of commercialization of innovations and their interconnections, accumulating human, financial and other resources for intensification, optimization and efficiency of commercialization of innovations" [13].

Objectively, IES is a set of research and commercial systems [14, 15]. The development of IES should be accompanied by the creation of a sustainable system of reinvestment of profits and economic interdependence of system actors (*Fig. 1*).

The influence on the IES, the consolidation of its members is a developed regulatory and interested external institutional environment. Thus, IES in perspective "objectifies to the national IES and its regional segments, which form a unified metasystem" [16, 17].

The ecosystem on the localization of innovation processes is an open system, which is a permanent search for competencies. Organization can be an actor of a number of ecosystems; actors transform technological solutions, structure, behavior. As a result, an ecosystem property is formed the ability to self-development (*Fig. 2*).

The evolving environment formed on the basis of complementarity and network equality of actors is recognized as a key element in IES [5, 18]. The positions where the development of IES is linked to the effective management of the evolution of incoming platforms and communication technologies are known; the focus is on public and corporate strategies that stimulate the introduction of innovation at the national level [19].

In support of the J. Moore theory, there is the end of the era of competition between companies and its development between the business ecosystem and the IES [20]. At the same time, if the business ecosystem aims to obtain value, IES aims to create a new value.

The structure of the economy, in the form of a rigid separation of sectors, is being transformed into an interwoven structure, and a significant proportion of value chains will be integrated into several ecosystems [14].

Finally, IES is positioned as the next step after an inter-firm strategic alliance (further — ISA) in the business system evolution chain [10, 17, 21], succeeding both features of traditional forms of economic relations (market, inter-firm contract agreement, intra-firm hierarchy) and network structures (*Fig. 3*).

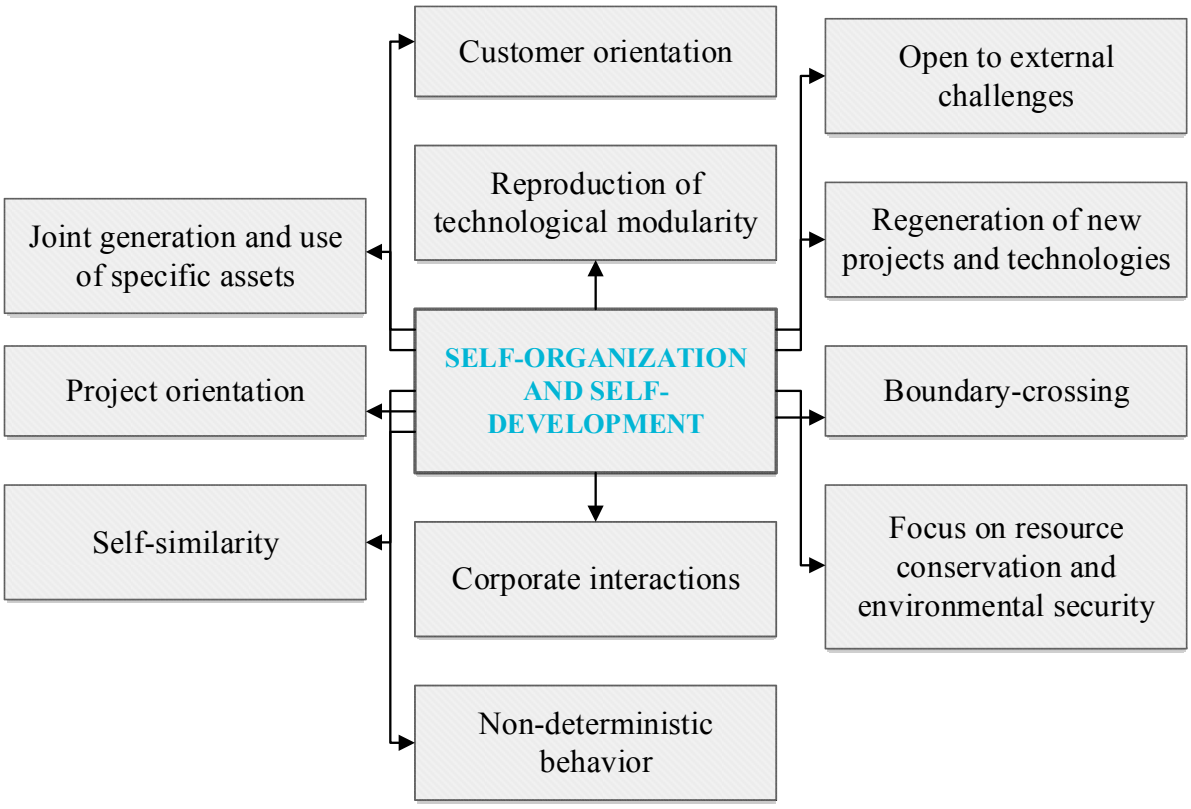

Fig. 2. **Key Properties of the IES**

Источник / Source: составлено авторами / Compiled by the authors.

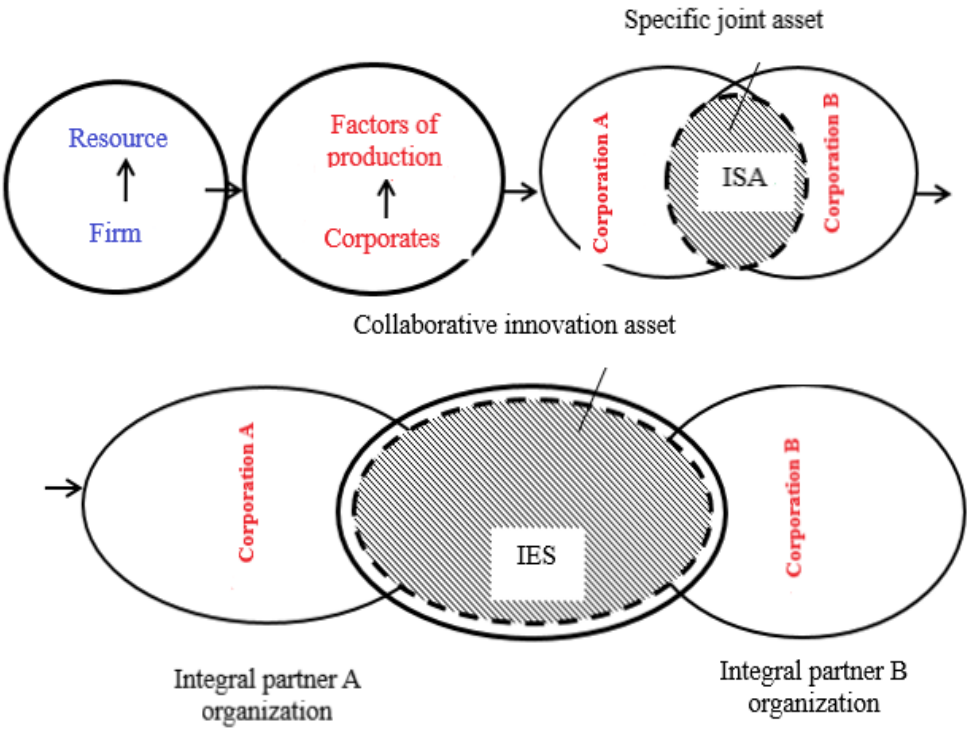

Fig. 3. **The Place of the IES in the Chain of Evolution of Business Systems**

Source: [22].

Table 1

Ranking of Countries by the Level of the Global Innovation Index

Position on the level of the GII	The economy of the State	The value of the GII	Rating by income level
1	Switzerland	65.5	1
2	Sweden	63.1	2
3	USA	61.3	2
4	UK	59.8	4
5	Republic of South Korea	59.3	5
6	Netherlands	58.6	6
7	Finland	58.4	7
8	Singapore	57.8	8
9	Denmark	57.3	9
10	Germany	57.3	10
11	France	55	11
12	China	54.8	1
13	Japan	54.5	12
14	Hong Kong	53.7	13
15	Israel	53.4	14

Source: Global Innovation Index 2021. URL: https://www.wipo.int/global_innovation_index/en/2021/ (accessed on 25.04.2022).

IES AND TECHNOLOGICAL CLUSTERS: COMPARE AND CONTRAST

Recognizing IES as a new organizational integrity and a way to produce innovation, some authors focus on the property of segmentation by cluster-network structures [23]. It should be noted that there is no single IES typology. An example is the classification proposed by the authors S. Zahra and S. Nambisan with four models [24]. This emphasizes the positional difference between IES and clusters. It is proposed to consider only ecosystems, where there is an integrating cluster project in the format of the triple spiral by Etzkowitz-Leydesdorff, which brings aggregated innovative effects [25]. Participation of the state in the network interaction do not have to IES.

In addition, unlike a cluster, the central subject of IES can be a digital platform that removes the transaction cost barrier [14]. O. Valdez-de-Leon considers that digital progress will ultimately transform any ecosystem of stakeholder interactions into a digital ecosystem [26].

The presence of developed IES determines the vector of development of economies, many IES occupy a monopolistic position in the national or world markets. High parameters of innovative development of the state are the basis for the value of the global innovation index (GII), contributing to the creation of new and development of the already established IES. The values of GII-2021 according to WIPO (World Intellectual Property Organization) are presented in *Table 1*.

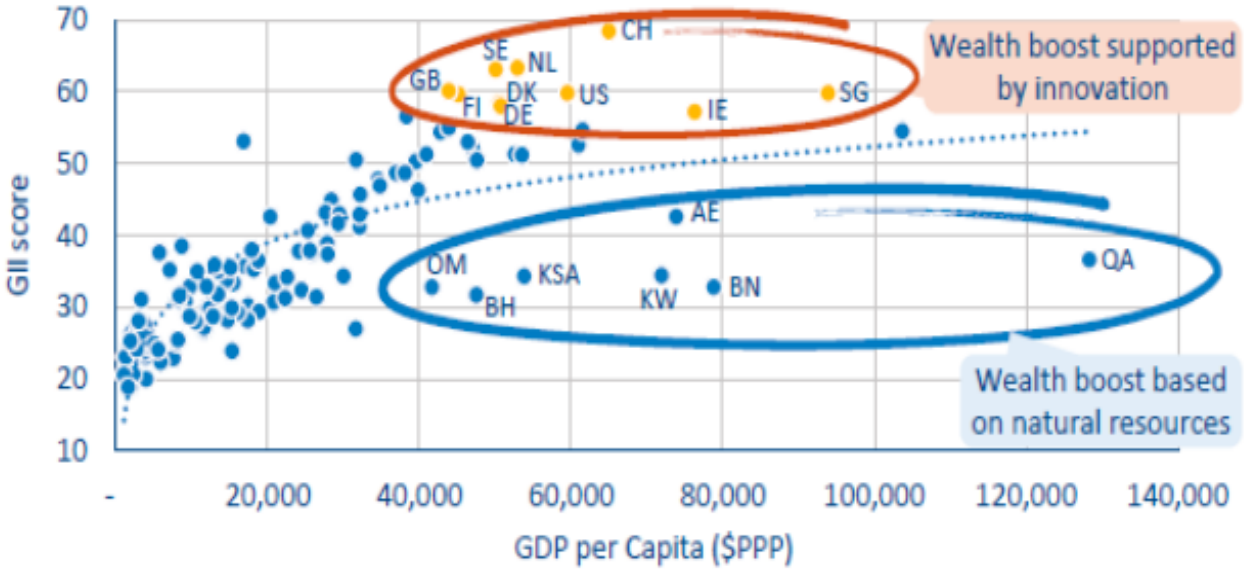

Fig. 4. **The Relationship Between Innovation and Economic Performance**

Source: National innovation ecosystem. URL: https://www.adlittle.com/en/insights/viewpoints/national-innovation-ecosystem (accessed on 20.04.2022).

According to *Table 1*, the world's most innovative economy in 2021 is Switzerland. Determinants of leadership — territorial ownership; dual basis of IES construction, significant wealth of the state; concentration of assets and financial capital of leading TNCs.

Fig. 4 shows the correlation between innovation (according to the GII index) and the country's wealth (according to GDP).

According to *Fig. 4*, countries achieve financial results and competitive advantage by owning natural resources and strengthening innovation leadership. At the same time, it should be stressed that IES models are lead role in the development of the national innovation strategy.

Thus, a technology cluster should be considered as a type of IES, provided that the focus is on reproduction of an innovative asset within a region with government involvement in networking. The digitalization of business space, the emergence of new digital ecosystems with the advantage of minimizing transaction costs, do not mean a reduction in the role of technology clusters. In contrast, national innovation strategies should focus on supporting technology cluster initiatives, especially in startups.

IES AS AN EFFECTIVE MECHANISM FOR DEVELOPMENT OF STARTUPS

The basis of successful IES was the development of a venture capital project startup. The rating of startup ecosystems on the basis of territorial ownership is presented in *Table 2*.

The number of ecosystems (*Fig. 5*) is growing significantly in the period 2013–2020, and the cost of startups of the 100 largest developing ecosystems in 2020 amounted to more than 540 billion dollars, which is 55% more than in 2019.

In the context of statistics (*Fig. 5*), it should be emphasized that in the 100 largest ecosystems in 2011–2020, startups with a total cost of 124 billion dollars, called unicorns, were created. IES are paying increasing attention to deeptech solution.

According to *Fig. 6*, Europe (37%), North America (30%) and Asia (19%) are the leaders of IES.

Using data from *Fig. 6*, it should be noted that in the EU and the USA, the most successful start-ups are based on universities or large companies. The uniqueness of IES Silicon Valley is that many of the unicorn companies that have since become

Table 2

Startup Genome Rating of Operating Startup Ecosystems Based on Territorial Affiliation in 2021

	Rating	Efficiency	Financing	Relationship of elements	Market coverage	Concentration of science and knowledge	Uniqueness of human resources
Silicon Valley	1	10	10	10	10	10	10
London	2	10	10	10	10	7	9
New York	2	10	10	10	10	5	10
Beijing	4	10	9	5	9	10	10
Boston	5	9	10	3	9	5	10
Los Angeles	6	9	10	3	9	7	9
Tel Aviv	7	8	9	8	10	4	8
Shanghai	8	10	7	1	9	10	9
Tokyo	9	8	9	1	8	9	9
Seattle	10	9	7	7	8	7	8

Source: Report on the global ecosystem of startups by the end of 2021. URL: https://about.crunchbase.com/blog/startup-genome-2021-global-startup-ecosystem-report/ (accessed on 20.04.2022).

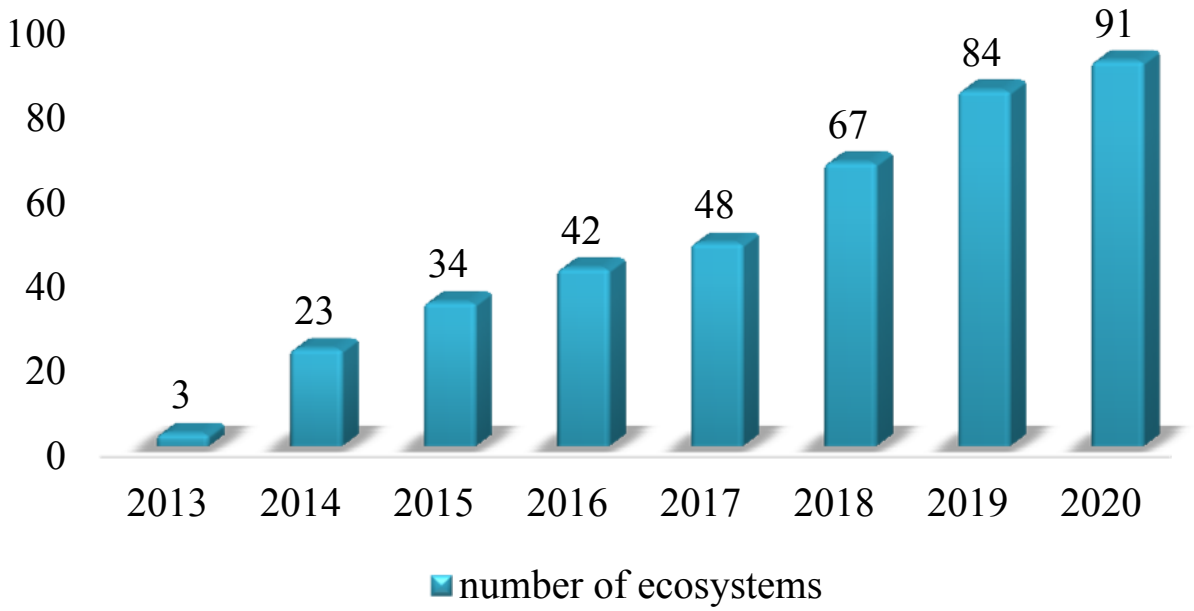

Fig. 5. **The Number of Ecosystems with Billion-Dollar Startups**

Source: Startup Genome. URL: https://startupgenome.com/reports/gser2021 (accessed on 15.04.2022).

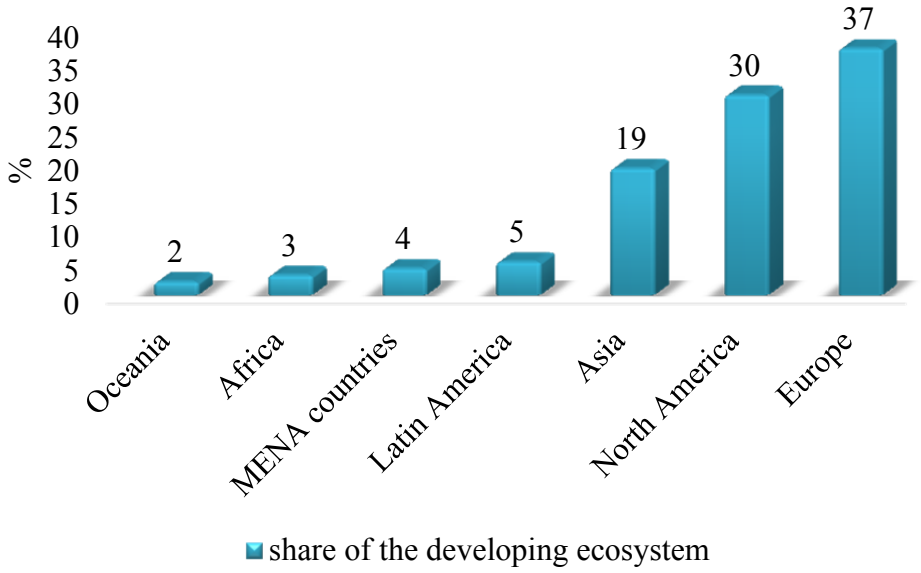

Fig. 6. **Share of Developing Ecosystems by Geographical Affiliation, %**

Source: Startup Genome. URL: https://startupgenome.com/reports/gser2021 (accessed on 15.04.2022).

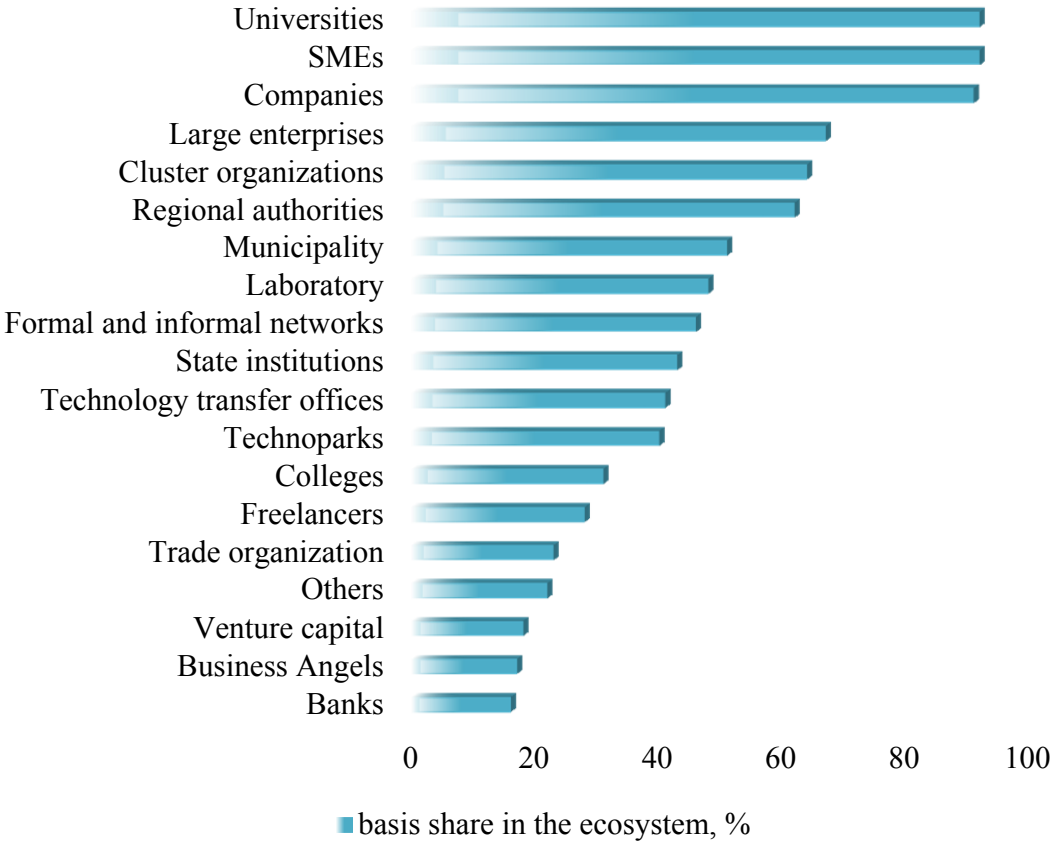

Fig. 7. **Identification of Ecosystems by a Fraction of the Basis**

Source: Innovation Ecosystems in Europe. URL: https://ec.europa.eu/futurium/en/system/files/ged/final_study_on_innovation_ecosystems_ in_europe_imec_smit_komorowski.pdf (accessed on 10.04.2022).

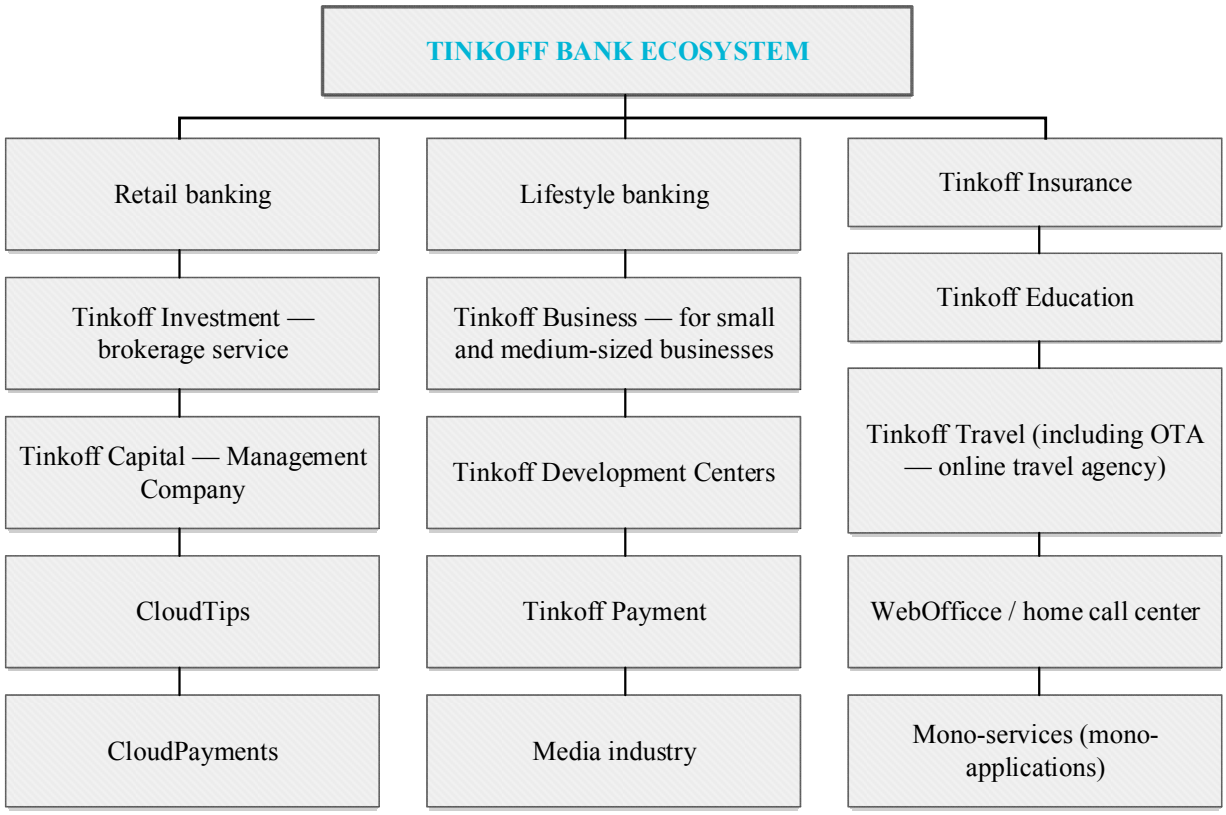

Fig. 8. **Elements of the Tinkoff Bank Ecosystem**

Source: [27].

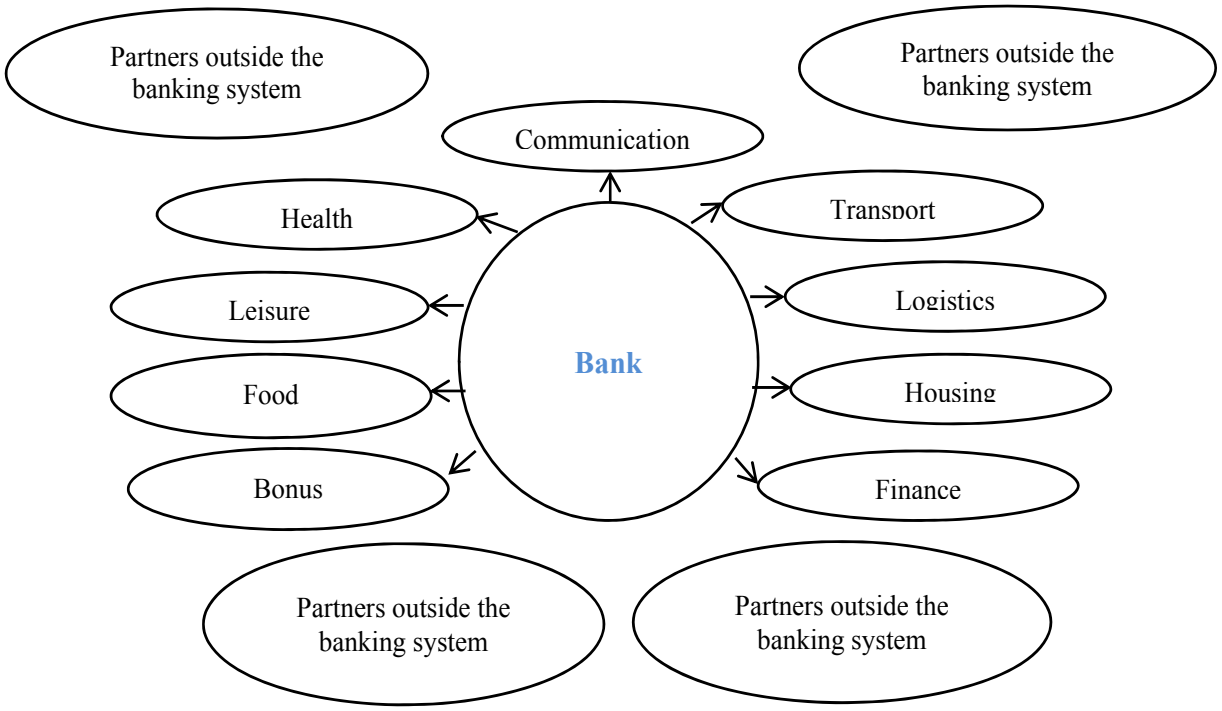

Fig. 9. **Scheme of the Russian Banking Ecosystem Model**

Source: [27].

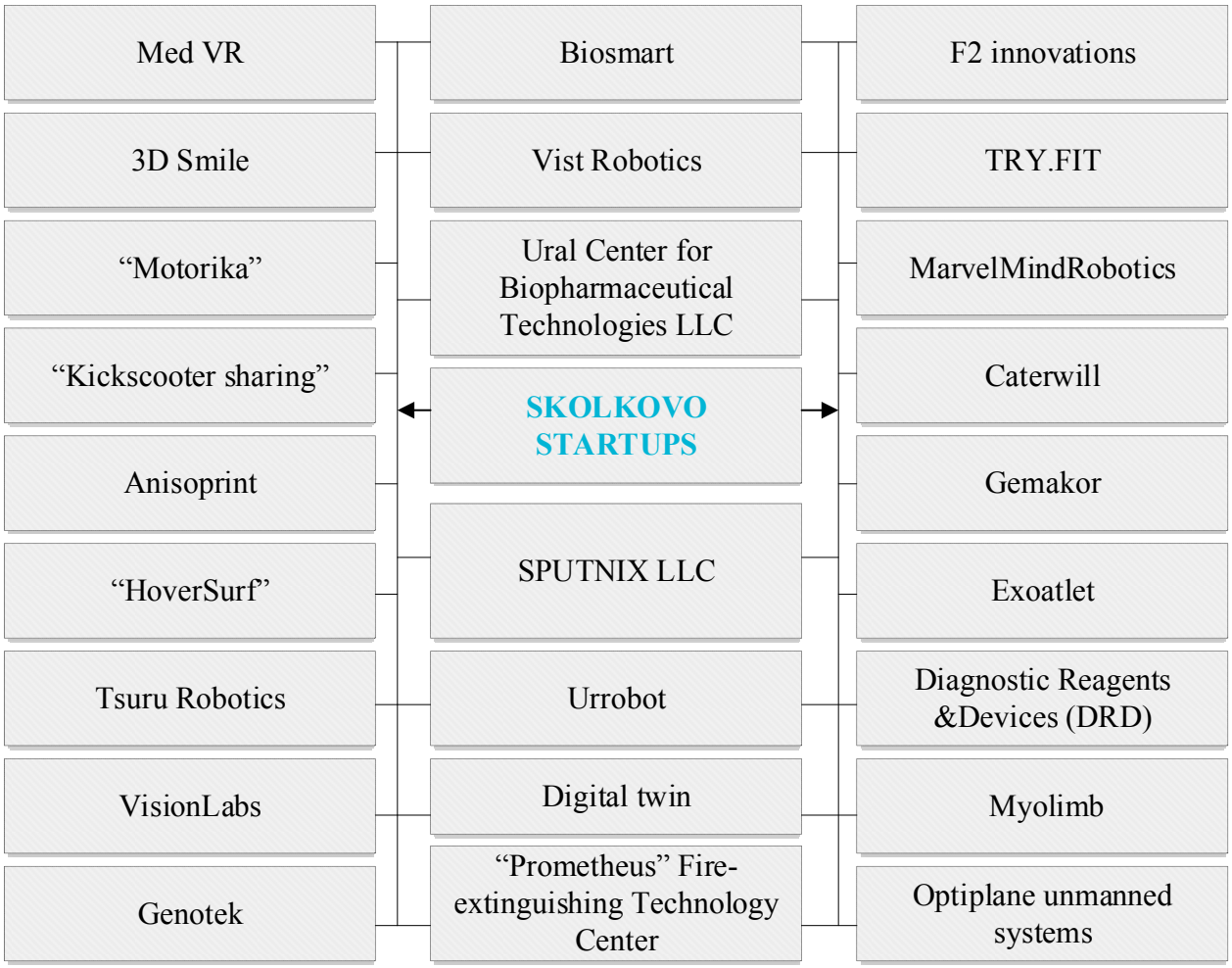

Fig. 10. **Startups of the Skolkovo Innovation Center**

Source: The best projects in Skolkovo. URL: https://skolkovo-resident.ru/proekty-skolkovo/ (accessed on 15.04.2022).

independent and the largest IES in the world have been its startups. In Startup Genome Rating the second place is given to London, where the startup Revolut was created. It is a fintech company that provides a service for converting currencies without bank commissions through exchange at the average exchange rate.

On *Fig. 7* reflects the contribution of various institutional segments (universities, representatives of ISA, companies, municipalities, laboratories) in the formation and development of IES in European countries.

In Russia, the approach to the IES basis is special: most IES are initiated and developed around major banks. Tinkoff is trying to build own ecosystem based on a super-application (Super App), which focuses on financial and non-financial directions (*Fig. 8*).

Sberbank develops some proposals independently, but a number of solutions completely buys out the development teams, thereby transferring prospective for the bank external initiatives into its own IES (*Fig. 9*).

So, according to the *Fig. 8* and *9*, it can be concluded that the banks are moving towards the implementation of the ecosystem lifestyle banking model with maximum satisfaction of formed and prospective customer needs in one application [27].

However, technology companies have experience in creating IES. In Russia, the analogue of the Silicon Valley functions in the form of the center of Skolkovo, created on the direct initiative of the State. The most famous startups of Skolkovo are reflected on *Fig. 10*.

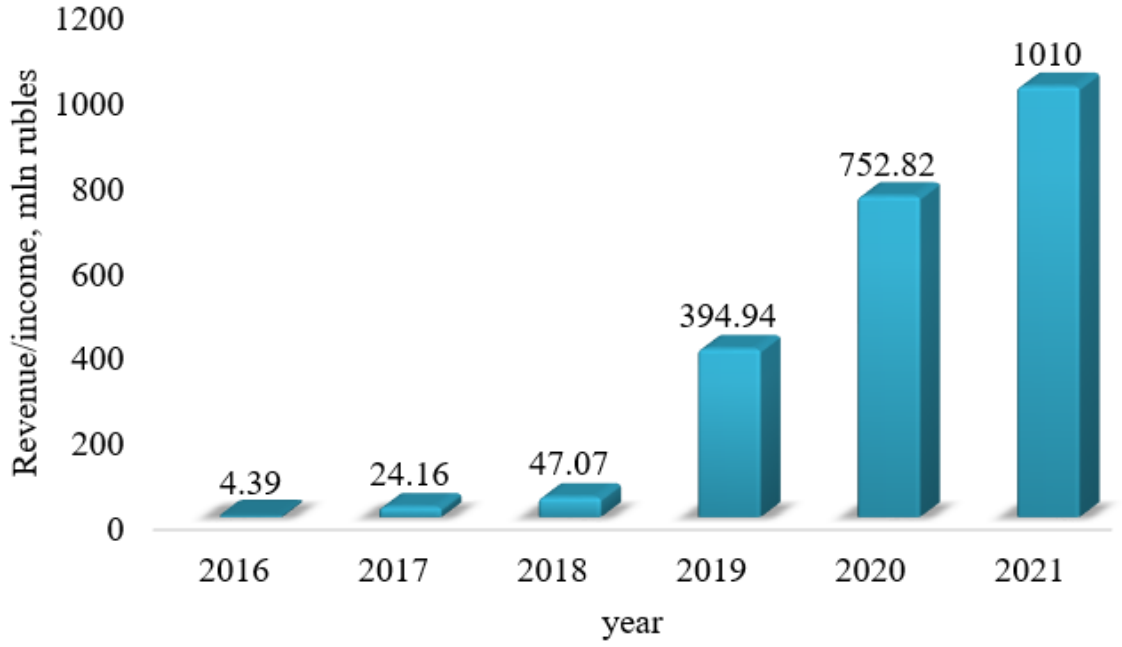

Fig. 11. **Revenue (Including "Other Income") of Ntechlab, a Resident of Skolkovo, in the Dynamics of 2016–2020, Million Rubles**

Source: About NTECH LAB. URL: https://companies.rbc.ru/id/1157746622109-ooo-nteh-lab/?ysclid=lheleu4ksj397494476 (accessed on 15.04.2022).

According to *Fig. 10* startups of Skolkovo have various functional affiliations. It is important that, according to 2021, the resident Skolkovo Ntechlab entered the list of "unicorns" [category Minicorns ("mini-unicorns")]. The revenue of Ntechlab in the dynamics of 2016–2020 is reflected on *Fig. 11*.[1]

According to *Fig. 11* total company income for the analyzed period increased by 22 906.83% with one-time support of the fund "Skolkovo" in the amount of 415 735 rubles within the microgrant. Ntechlab implements 11 key projects in which State institutions perform the role of the customer.

Thus, despite the differences of startup-IES models in different countries and regions, their development and the building of support tools mediate the reproduction of a new generation of "unicorns" — deeptech-startups and companies, opening new areas for development at the interface of disciplines, characterized by versatility, application in a wide range of industries.

CHINA'S SPECIAL DIGITAL IES MODEL: REALITY AND TARGET

In China, three main territorial centers of IES were identified, the key characteristics of which are presented in *Table 3*.

According to *Table 3*, there is: division by activity, clear functional diversification, active appearance of unicorn companies.

One of the first IES formed on the basis of the largest digital giants, which contributed to the build-up of influence through both financial success and the mass audience. The significant impact of ecosystems on a particular market is illustrated by the example of the duopoly in the retail payment market (Alipay and Tenpay).

China has 9 Internet giants with 100 small but fast-growing unicorn companies. One of them — Bytedance is the only hectocorn in the world, and the other eight are among the world's top 20 largest companies in terms of capitalization. As a result, China is a world leader on key parameters of the digital economy (*Fig. 12*).

[1] About Ntechlab. URL: https://sk.ru/news/rossiyskiy-ntechlab-poluchil-status-miniedinoroga/?ysclid=lhelhupkgz93858754 (accessed on 15.04.2022).

Table 3

Three Key Centers of China's IE

Specifications	Beijing	Shanghai	Shenzhen
Ecosystem value, billion dollars	445	157	71
Significant specification	Outstanding educational resources	Global Financial Centre, largest port	Location place of the testing for economic transformation; special economic zone
The largest unicorn companies	Alibaba, ByteDance	Lufax, Zhangmen	Tencent, Huawei, Vanke
Characteristics	93 unicorn companies, 13 public fintech-companies with capitalization of 16.35 billion dollars; Silicon Valley analogue — Zhongguancun (10 artificial intelligence laboratories, 9000 technology companies)	Base for 42 unicorn companies for the location of foreign companies	Shenzhen — enlarged analogue of Silicon Valley; zone of political and economic experiments at the city level; about 300 foreign companies from the Fortune-500 list operate on the territory
Significant investment deals	Yuanfudao (EdTech) raised 1 billion dollars; Xiaomawang (coding training) raised 21.2 million dollars; Shumei Technology (business risk management) raised 208 million dollars	Series B investment of 735.85 million dollars for Enovate Motors; Series E investment of 315 million dollars for Zhenkunhang; 310 billion dollars for startup LianBio at an early stage	ArchForce Financial Technology raised 18.3 million dollars in series B investments; Intellifusion raised 141 million dollars; SmartMore Technology raised 131 million dollars
Profile instruments	FinTech, AI, BigData/ Analytics	EdTech, Gaming	FinTech, AI, BigData/Analytics

Source: Startup Genome Report. URL: https://startupgenome.com/ (accessed on 08.03.2022).

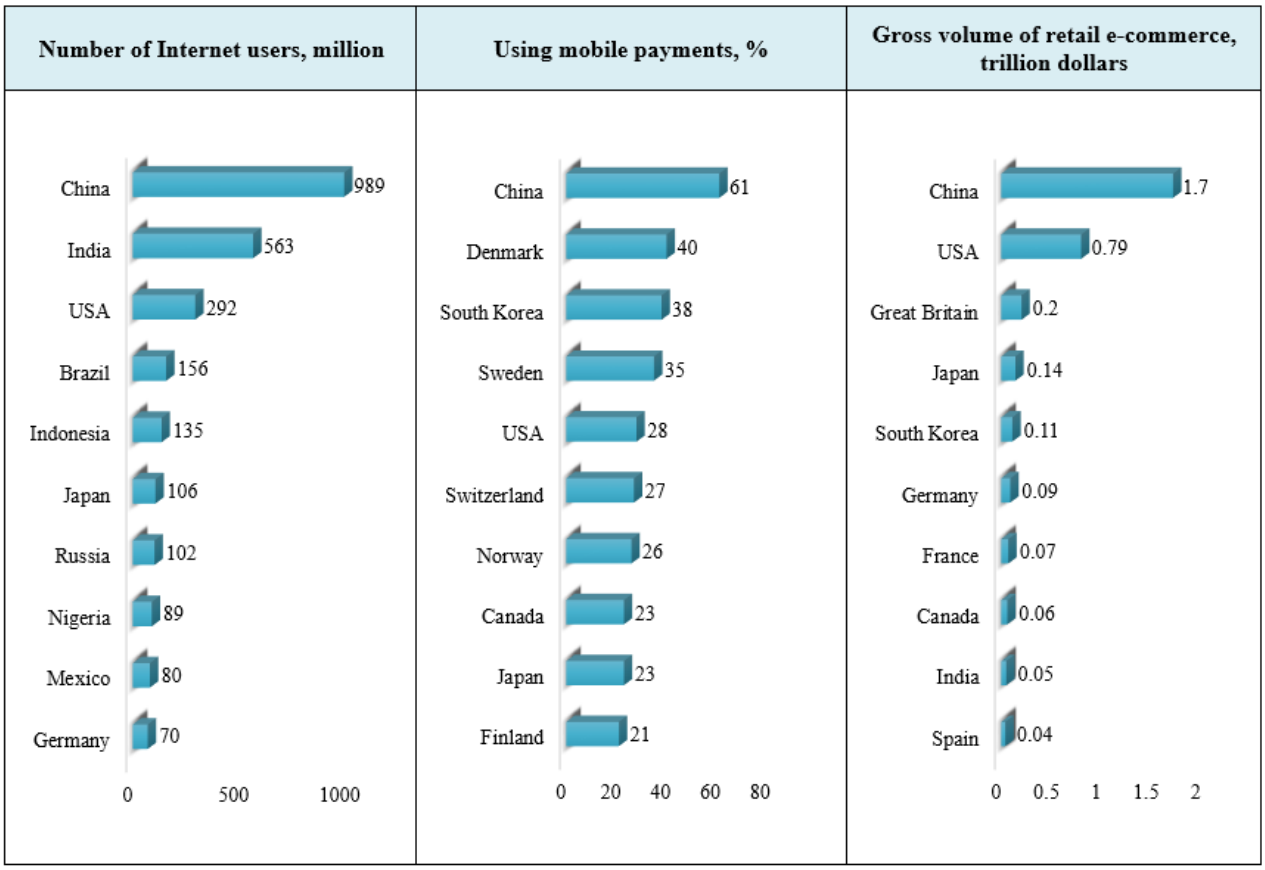

Fig. 12. **Key Parameters of China's Digital Economy as the Basis for the Development of the National Model of the IES**

Source: Future digital innovation in China. URL: https://www.mckinsey.com/~/media/mckinsey/featured%20insights/china/the%20future%20of%20digital%20innovation%20in%20china%20megatrends%20shaping%20one%20of%20the%20worlds%20fastest%20evolving%20digital%20ecosystems/future-of-digital-innovation-in-china.pdf (accessed on 12.04.2022).

The Chinese model should be recognized as the largest national IES. Due to the impressive size of the population, IES interests are objectively focused on the national market, and international expansion is less expressed in the priorities of strategy and action.

Digital IES is the result of the growth of e-commerce in China. At the same time, the Chinese model in a special format implements the principle of system. Companies diversify innovative products closely linked by presence on the same platform, that related to polarly different spheres of presence. State support for the development of IES consists not in the provision of grants tranches, but in "non-interference to demand".

Thus, the analysis of the Chinese IES model showed its competitive advantage:

- presence of a prepared and responsive market for new technologies;
- creation of the "testing ground", that did not have the world analogues with the ability to implement all innovations up to the main mass launch;
- reproduction of a special competitive environment that allows exogenously and endogenously compete with startups, companies;
- decisive position of big companies — giants of digital economy, which means exponential reproduction of startup-innovations and consumer loyalty;
- promotion of startups leads to the creation of companies that build their IES;
- special public policy of adaptive intervention;

• focus on digital networking by giving up a number of traditional corporate values and tools.

CONCLUSION

The research made it possible to conclude that IES is an open institutional mechanism for research and commercial reproduction of innovation, transforming the competitive market environment towards the dominance of sustainable intersectoral networks. IES can be an important tool in the transition to a new technology-based economy, and the externalities created by the technologies themselves will be neutralized through innovation.

Among the characteristic of IES' properties identified: openness, interactivity, dynamism, stability, hierarchy. In the context of reproduction — advantages of IES — the prospect of the model of the Chinese national IES, which should be recognized as a benchmark of the strategic innovation development of Russia with a shift of emphasis from the construction of ecosystems by leading financial organizations in the direction of the formation of territorial centers of location of technological IES.

Further scientific and practical research can go in one of two ways. First, we should examine what quantitative and qualitative factors, as well as management strategy and technology, can influence the innovation dynamics of companies and their further transformation into ecosystems. And secondly, we should consider what specific economic policies can help the development and adjustment of inefficient IES, in the context of modern innovation processes.

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I.A. Ezangina — statement of the problem, development of the concept of the article.
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