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Economics of Education

The Role of Program and Project Management in Increasing the Competitiveness of Russian Universities: A Comparative Analysis Including China and India

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Abstract

As the worldwide economic paradigm changes, higher education becomes an extremely important factor in ensuring a country's scientific and technological sovereignty. This article compares the state of higher education in the Russian Federation (RF), the Republic of India (RI), and the People's Republic of China (PRC) and ranks the development of their respective higher education systems in order to derive a model for advancing the innovative competitiveness of the RF's institutions of higher education and to identify the components required to make them more competitive. Study of statistical data and regulations along with retrospective and systemic structural analysis indicate that program and process management is an innovative way to increase the competitiveness of universities. This result is grounded in a descriptive analysis of previous scientific studies, which substantiated the authors' definition of what makes universities competitive. Comparison of the programs and projects implemented in the three countries examined leads to the conclusion that the RF should accelerate the creation of a wide network of program and project initiatives in higher education. Although a comparative analysis of the RF's nationwide Project 5–100 and Priority 2030 program reveals certain problems in university management, it also establishes that applying existing regulations for strategic planning as well as for program project management in order to develop universities can assist in reaching the targets of Presidential Decree No. 145 dated 28 February 2024, entitled "Strategy for Scientific and Technological Development of the RF" (SSTD).

Keywords: technological sovereignty, competitiveness of universities, strategic planning, human capital, educational management.

JEL: H75, I23, I28, O15.

Introduction

Abbreviations used	
CI	Control inputs
FL	Federal law of the Russian Federation
FP	Federal Project
GDP	Gross domestic product
GP	Government program
GB	Governing body (of a university)
HC	Human capital
IFPOEP	Innovative, flexible, practice-oriented educational programs
IC	Intellectual capital
NP	National Project
PD	Presidential decree of the Russian Federation
PFPD	Programs for professional disciplines
PIC	Professionally important competencies
PRC	People's Republic of China
R&D	Research and development
RF	Russian Federation
RI	Republic of India
SSTD	Strategy for Scientific and Technological Development
6 STP	Sixth scientific and technological paradigm

Mirjana Spoljaric Egger, President of the International Committee of the Red Cross, made a presentation at the scientific and technological conference held in September 2023 under the auspices of the Suzhou University of Science and Technology of China, in which she stated that there are more than one hundred armed geopolitical conflicts in the world and reaffirmed this fact at a meeting with the Chairman Xi Jinping. This should come as no surprise because changes in technological and global structures are always accompanied by structural political crises in government institutions and global geopolitical conflicts [Glazev, 2022b]. The close connection of world economic relations due to globalization and the international division of labor is collapsing between the parties to these conflicts and is causing a shock to the entire world economy. The world is also undergoing a transformation of the forms of social economy to the sixth scientific and technological paradigm (6 STP) as part of the next scientific and technological revolution hypothesized by Glazev and others. This next stage will radically increase the pace of innovation and alter the main paths that countries will take in their scientific and economic development [Glazev, 2022a].

All the traditional leaders in innovation are G20 member countries as Table 1 shows. The top 10 have been almost static and consist of Western countries with the solitary exception of Singapore. Moreover, recent studies show that two thirds of global innovation expenditures

Table 1

Changes in Rank Among Countries Leading in the Global Innovation Index

Country	2023	2016	2013
Switzerland	1	1	1
Sweden	2	2	3
USA	3	4	6
UK	4	3	2
Singapore	5	6	7
Finland	6	5	4
Holland	7	9	5
Germany	8	10	13
Denmark	9	8	8
China	12	25	29
India	40	66	76
Russia	51	43	56

Source: authors' compilation of data from the Global Innovation Index: www.wipo.int.

are made by the PRC, RI and the USA [Zeldner, Osipov, 2020]. Studies of the scientific and educational potential of the BRICS countries have found that they are becoming more comparable to the top 10 countries, although there is room for growth in introducing innovations and developing the education sector [Ponomarev et al., 2023]. Under such circumstances, developing higher education and human capital while also integrating project management become the best ways to enhance a country's scientific and technological potential [Wang et al., 2022]. Current global challenges and geopolitical conflicts were discussed at the meeting between Vladimir Putin and Xi Jinping in Beijing on 2 April 2022. The parties announced the acceleration of the One Belt One Road initiative for EAEU development. One of the goals of this plan involves increased interconnection of the sustainability of the two countries' economies, mutual integration among their universities, and exchange of experience in developing human capital and higher education.[1]

A principal problem for the RF's development is its lagging scientific and technological competitiveness in innovative products when compared to other economies. This deficiency is confirmed by the RF's 2023 ranking at 51 in Table 1, a loss of eight points during the seven years since the publication of the first Strategy for Scientific and Technological Development (SSTD).[2]

[1] Joint statement of the Russian Federation and the People"s Republic of China on international relations entering a new era of sustainable development between countries. http://www/kremlin.ru/supplement/5770/.

[2] Decree of the President of the Russian Federation dated 1 December 2016 no. 642 (in the version of 15 March 2021 no.143) "Strategy for scientific and technological development of the Russian Federation." *Compendium of Legislation of the Russian Federation*, no. 49, 2016, p. 6887.

The RF government publicly recognized the lag in the Address of the President of the RF dated 29 February 2024, which was intended to strengthen the technological sovereignty and security of the RF by updating the SSTD and resolving to accelerate the strategic development of the country through training one million highly qualified specialists who will become involved in domestic innovative enterprises.

The central documents emphasizing the urgency of rectifying the problems of higher education in the RF are the following Presidential Address and Decrees (PD):

- Address dated 29 February 2024 from the President of the RF Vladimir Putin to the Federal Assembly;
- PD no. 145 dated 28 February 2024 "On the strategy for scientific and technological development (SSTD)"[3] which highlights the provision of technological sovereignty by increasing and effectively using the intellectual potential of the nation;
- PD no. 343 dated 12 May 2023 "On certain issues in improving the higher education system"[4] which directs reform of higher education through a synthesis of the best practices of the USSR and successful elements of the Bologna system;
- PD no. 309 dated 7 May 2024 "On the national development goals of the RF by 2030 and through 2036"[5] which envisages the RF establishing a more effective system of higher education and becoming one of the ten leading countries in the world for amount of scientific research.

These PDs outlined the main challenge to be met by developing higher education in the RF — carrying out the SSTD and ensuring the country's competitiveness by using innovative methods in university management and developing human capital (HC) through higher education. This study examined the educational systems of the RF, PRC and RI, and its research hypothesis follows from the projections of the SSTD in PD no. 145 and the Address of the President of RF to the Federal Assembly dated 29 February 2024. Those projections envisage an increase in the competitiveness of the RF and defense of its sovereignty by means of forming two new national projects called Youth and Personnel, training one million highly qualified specialists

[3] Decree of the President of the Russian Federation dated 28 February 2024 no. 145 "Strategy for scientific and technological development of the Russian Federation." *Compendium of the Legislation of the Russian Federation*, no. 10, 2024, p. 1373.

[4] Decree of the President of the Russian Federation dated 12 May 2024 "On certain issues in improving the higher education system." *Compendium of the Legislation of the Russian Federation*, no. 20, 2023, p. 3534.

[5] Decree of the President of the Russian Federation dated 7 May 2024 no. 309 "On the national development goals of the Russian Federation by 2030 and through 2036." *Compendium of the Legislation of the Russian Federation*, no. 20, 2024, p. 2584.

for enterprises employing innovative technologies that feed into the 6 STP, and accelerated development of higher education to facilitate program and design efforts. This broad initiative is intended to enhance the competitiveness of Russian universities, expedite mastery of 6 STP technologies, and ultimately strengthen the sovereignty and independence of the RF.

1. Theoretical Aspects of the Study

Education drives the innovative, scientific, and technological development of a country [Roberts, 2017; Strasser et al., 2019; Zhou, Luo, 2018]. It follows that increasing the competitiveness of a country depends on the competitiveness of its higher education. Minister Valery Falkov and Deputy Prime Minister of the RF Dmitry Chernyshenko made a joint statement at the headquarters of the Ministry of Education and Science, during which they advocated following the SSTD and recognized universities as the chief instrument now available for advancing science, innovation, and human capital (HC) in the RF.[6] These pronouncements place the competitiveness of the university as such in the vanguard of progress. An innovative way to increase competitiveness through university management could be the implementation of Federal Law no. 172 "On Strategic Planning in the RF," which addresses program and project management, especially inasmuch as this approach is also integral to the Address of the President of the RF dated 29 February 2024 and PDs no. 145, 343 and 309. Therefore, this article's review of theoretical aspects will concentrate on three key components: defining what makes a university competitive; examining higher education as an instrument of and source for the development of HC, science, and innovation; and efforts devoted to a program and project approach to the development of universities.

Higher education and human capital as main components of innovative, scientific, and technological development

The Personnel for the Digital Economy federal project and the Digital Economy national program have laid the foundation for intensive development of the knowledge economy in the RF as specified in the Priority 2030 state program.[7] The main objective of the program is to increase the share of Russian science and universities in the global and

[6] Technoprom 2023 Forum held by the Ministry of Education and Science of the Russian Federation. https://Форумтехнопром2023.рф.

[7] Decree of the Government of the Russian Federation dated 13 May 2021 no. 729 "On measures to implement the Priority 2030 strategic academic leadership program." *Compendium of the Legislation of the Russian Federation*, no. 22, 2021, p. 3823.

national research market so that Russian institutions will subsequently function as centers for the implementation of the SSTD. Hence, the role of the university's intellectual capital (IC), which is based upon HC, is set to expand. For the purpose of this study, however, IC and HC are not treated as concepts equivalent to each other. A group of authors at the end of the twentieth century laid the theoretical foundation for a definition of IC considered as a resource that includes intellectual property, brands, and programs that organizations possess; and HC is its main component [Brooking, 1996; Edvinsson, 2000; Kianto et al., 2017; Stewart, Stephanie, 1994]. Increasing the university's IC in applied research, generating innovative ideas, and mastering innovative technologies is impossible without human capital, which in turn depends upon the intersection of an individual's intellect, their personal and practical experience, and their intellectual achievements. This was acknowledged at the state level by the President of the RF with the inception of two new National Projects (NPs) with the indicative titles Youth and Personnel. The effective use of human capital is one of the main conditions for ensuring high rates of economic growth [Kapelyuk, Lishchuk, 2022; Wang, Yang, 2022].

The classic works of Adam Smith, William Petty, Theodore Schultz, Gary Becker and others have provided the fundamental contribution to the formation and elaboration of the theory of HC and its connection with education [Vefago et al., 2020; Weifang, 2017]. These authors established the role of human abilities in the production and capitalization of organizations and highlighted the results of increasing the level of education. Human resources were recognized as a form of capital, and the importance of investing in higher education was justified by the contribution it makes to increasing capital. At a later stage, HC was recognized as the basis for innovation and increased labor productivity in a country's economy as the impact from higher education training programs that advanced qualifications became clear [Ramstad, 2009].

The pressure from sanctions on the RF must be taken into account by this study. Work by Matthias Neuenkirch and Florian Neumeier confirmed the impact of these sanctions, which have led to a cumulative decline in scientific potential and a drop in the country's economic activity from 2.5 to 6% of GDP per year [Neuenkirch, Neumeier, 2015]. A decline of this magnitude in the country's GDP may trigger a reduction in funding for higher education. Given the distinctive features of the RF and high levels of competition between universities, this may lead to decreasing quality of education due to lower requirements for educational programs and professional disciplines. Gagik Mkrtchyan connected the differentiation and competitiveness of uni-

versities in the RF with the separation of education from science and with the varying quality of HC at universities [Mkrtchyan et al., 2017]. It was later found that countries with a high level of human capital development and robust educational systems are resistant to economic shocks [Ngouhouo et al., 2019]. Alexei Alekseev found that innovations and systemic investments in the development of HC brought about an upward trend for labor productivity in the Russian economy analogous to that in developed countries' innovations and systemic investments in the development of HC [Alekseev, 2019]. Anna Bulina held that the stock of human capital determines the technical progress of a country [Bulina et al., 2020]. Daria Avdeeva offered a systematic map of methodological approaches for assessing the effectiveness of investments in HC [Avdeeva, 2022]. In the unfavorable situation that the country faces, a group of researchers attaches special importance to the development of HC in regional higher education throughout the RF [Baranov et al., 2021; Sorokin, 2023a; 2023b; Tagaeva et al., 2020]. These authors believe that this would constitute an important support for consolidating HC and augmenting the scientific and innovative potential of the country's economy. According to the position of another group of authors, public universities can generate innovative ideas that contribute to the future development of HC provided that they apply the New American University model, the effectiveness of which has been in the USA tested at several universities in Arizona [Crow, Dabars, 2017].

In general, the authors who have investigated the impact of higher education on the economic, scientific and innovative development of various countries have singled out higher education as the main factor in recent competition between countries [Aganbegyan, 2024; Čajka et al., 2023; Glazev, 2022a; Lopes, Farinha, 2018; Zhou, Luo, 2018]. Research by authors who systematically analyze spending on education and R&D as a share of GDP across a sample of several countries confirms a positive correlation between an increased investment in HC through higher education and an increase in both the technological and economic development of a country [Aganbegyan, 2024; Glazev, 2022c; Wirajing et al., 2023].

This article is not intended to cover the entire theory and assessment of HC for the RF. However, in testing the research hypothesis and accepting the projections of the Address of the President of the RF dated 29 February 2024 and of the relevant new national projects, this article will provide an analysis establishing that the development of HC through higher education is a crucial missing link in the RF's SSTD, which is aimed at increasing the country's competitiveness and technological sovereignty.

Program and project management in national higher education: Approaches and modeling

This retrospective analysis of program and project management methods will exclude international experience and will instead concentrate on the methodological aspects of RF research during the last decade. This choice has been made on the assumption that Russian authors will take into account the conceptual framework of strategic planning adopted in 2014 and Federal Law no. 172 "On Strategic Planning in the RF" together with PDs no. 204 and 309 as well as the distinctive features of higher education in the RF, all of which are central to this study.

Political conditions and modern trends in the state have over the past ten years formed what could be a new management contour in higher education — strategic management. A group of researchers were among the first to take these factors into account by using mathematical modeling; their calculations resulted in a proposal to use a portfolio of individual projects in the university development program [Mazelis, Solodukhin, 2014; Sandler, 2020]. Tatiana Patrakhina and Yuri Molotkov suggested including a set of project-based, socially oriented activities provided for in the university strategy as the basis for development of an entire region [Molotkov, 2020; Patrakhina, Vyalkova, 2018].

Research from another group of authors identified high-quality personnel policies at the university as areas for a university's growth and proposed inclusion of a corporate project management system, a program-targeted teacher certification plan, and a career development roadmap in a university's development strategy [Gorbunova, 2019; Ilyina, 2023; Shklyarova, 2018]. A series of experiments allowed Yuri Daneikin and Victor Babenko, to arrive at five principles for introducing the project approach into the methodology of educational programs and the individual trajectory of students in order to develop their soft competencies; these principles could be included in university development programs [Babenko, 2021; Daneykin et al., 2019].

A significant contribution to the development of strategic management and of program and project management came from a group of authors who proposed setting the mission and strategic goals of the university by comparing them with a range of indicators for the innovative and scientific development of their region and by encouraging broad interaction between teachers and the rector of the organization [Baryshnikova et al., 2019; Demin, 2019; Kurbatova et al., 2018; Polevoy, Chalova, 2019].

It is not feasible to cover the entire range of publications on these topics in order to show how they have evolved. However, extensive groups

of researchers were considered provided that, in the authors' opinion, their output had passed vetting by specialized and widely quoted scientific publications or else had been published as monographs.

Nevertheless, it was possible through analysis of the remaining sources to identify fragmentation among the measures proposed, and a number of "gaps" that require attention as problems demanding further study were exposed. Among these gaps were a whole range of factors pertaining to Government Decree (GD) no. 1288 "On project activities" as amended by GDs no. and 987[8] not taken into account; nor was Federal Law no. 172 "On strategic planning in the RF." The omitted factors include: the regulatory framework and state requirements for the passport (a document establishing the legal status of a future project), the specifics involved in integration of university projects with the state at the federal and regional levels, a reckoning of the risks and interests of all project stakeholders, identification of sources of funding, and requirements for changes in regulatory documentation and in management structure within the university. In addition, little attention was paid to providing suitable indicators for development projects and programs. These cannot be merely borrowed from other existing sources, as they would then lack any connection with the intermediate results in a university's development and would fail to incorporate the ways in which the academic structure participates formally in a university's management processes.

Theoretical approaches to the concept of competitiveness

The Address of the President of the RF dated 29 February 2024 and PDs no. 145, 343 and 309 lay out the high-priority paths of development of domestic higher education and establish that development as the main way to ensure scientific and technological progress and technological sovereignty for the RF. Therefore, it is necessary for the purpose of this study to be aware of the work of authors who have defended a dissertation on the topic of the competitiveness of universities in the RF. This is required both to arrive at methodological recommendations and also to understand the definition of the competitiveness of universities from the point of view of the academic community. Table 2 presents a combination of theoretical analysis pertaining to defining the term "competitiveness" in relation to different kinds of competition and also outlines the research of authors who have defended a dissertation on the topic "competitiveness of universities."

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[8] Russian Federation Laws. "On amendments to the Decree of the Government of the Russian Federation dated 31 October 2018 no. 1288" and Resolution of the Government of the Russian Federation dated 24 June 2021 no. 987 "On amendments to the Decree of the Government of the Russian Federation dated 31 October 2018 no. 1288". *Compendium of the Legislation of the Russian Federation*, no. 27, part 2, par. 5375.

Table 2

Definitions of Competitiveness

Author	Definition of the concept of competitiveness
General views of the founders of theoretical interpretations applicable in various contexts	
A. Smith	Rivalry between participants in the market, formed by its invisible hand (mercantilism) [Smith, 2007]
M. E. Porter	The ability of a country's industry to constantly develop and produce innovations through the productive use of resources as compared to other entities [Porter, 1991]
A. Granberg	An entity's ability to defend its position in the market [Granberg et al., 2000]
V. Medeiros	A relative characteristic that reflects the differentiation of a country's or organization's development according to the degree of activity in relation to competitors and the dynamics of adaptation to market conditions [Friedrich, 2017; Medeiros et al., 2020]
Opinions of authors who defended their dissertation on the topic "competitiveness of universities" from 2006 to 2023 in the RF	
R. A. Fatkhutdinov	Static state or dynamic ability of a university to successfully compete in the market for educational services [Fatkhutdinov, 2006]
A. Petersons	A condition in which the quality of educational services, consumer satisfaction with these services, research activities, and the reputation of the university are secured [Petersons, 2008]
A. N. Trotsenko	A relative characteristic that reflects the competitive advantages of a university in terms of the determining factors for meeting the needs of clients and that allows it to maintain a competitive position in the market [Trotsenko, Romanova, 2015]
A. V. Voloshin	The resource potential of a university, which provides competitive advantages in the market as it interacts with other market participants [Voloshin, 2017]
A. K. Khudadova	A condition characterized by the ability to promptly adapt a university to environmental conditions [Khudadova, 2018]
I. V. Baranova	The overall characteristics of a university's resources, which by means of mixed marketing tools enable it to secure a share of the relevant market for educational services provided by that university [Baranova, 2021]

Source: compiled by the authors.

This study does not engage in a full presentation of the theory of competitiveness, but touches on those aspects that may be of academic interest while taking into account the current state of the RF and the distinctive features of its higher education. The conclusion to be drawn from Table 2 is that competitiveness is considered by most authors as a state or characteristic in the socio-economic domain being studied. The authors assess competitiveness according to parameters borrowed from methods developed for the topics of their research. Analysis of the definition of the competitiveness of universities has demonstrated not only a lack of coherence in the theory of competitiveness of universities and little representation of the components of previous studies, but also significant gaps in university management's understanding of the essence of competitiveness when current circumstances and the distinctive features of the RF are taken into account. Current government guidelines are also being overlooked at a time when the future of the nation is at stake.

This rather chaotic condition requires clarification of the definition of the competitiveness of universities. For the current Russian context, the competitiveness of a university may properly be specified as a systemic mechanism for human development through higher education in the RF directed toward the transition to the 6 STP and implemented through program and design measures that align with the SSTD. Such a definition implies the following elements: (1) an organization's ability to navigate the country's key strategic planning documents and focus on the strategic goals of the country, region, and university; (2) an organization's ability to attract resources and stakeholders for the development of innovative educational programs; (3) a university's potential and capabilities to ensure its competitive positioning in the rankings applied to the educational services market. This approach to the development of university competitiveness will not only allow universities to be included in federal and national programs and projects for the development of higher education, but it will also ensure the technological sovereignty of the state through training scientific and highly qualified personnel by universities to meet the needs of the country as prescribed by the existing PDs and by program and design measures within the legal framework of RF.

2. Methodological aspects of the study

This study employed material from such prominent international statistical sources as the OECD, UN, UNESCO, the World Bank, and the IMF. The relevant ministries and government agencies in the three countries were consulted for published representative statistical information pertaining to the subject of this study for the period from 2013 to 2023, and these statistics were also used for this article.

A meta-analysis which combined statistical data with techniques for comparison and contrast yielded an assessment of the level of development in the higher education systems of the RF and also provided methodological recommendations. This approach enabled identification of trends and problems in the management of the country's universities.

As the first stage in this task, state programs and projects for developing higher education at the level of the RF were selected and analyzed. The effects of those nationwide programs and projects were described and projected, a process which can contribute to charting the future path of development for higher education and HC. The quantified results of this process were compared across all three countries. The larger and more ambitious the programs and projects, the more significant the effect upon a country's HC and its universities.

During the second stage, the process for increasing the competitiveness of a country's universities was modeled by means of a program and project approach.

For the third stage, a structural and systemic analysis of retrospective data from the three countries was carried out to determine the conditions and patterns for increasing the competitiveness of each country's higher education system. To do this, a matrix was created in which certain indicators of the knowledge economy in the three countries were presented in a way that clearly exhibited the relative standing and degree of development of higher education in the RF. The matrix included the following indicators: investment in R&D, investment in each country's education, ratings and indices for evaluating innovations and higher education systems, and the human capital resource base for higher education. This approach is consistent with the modern neoclassical theory that economic growth is based on the scientific and technological development of a country, which in turn requires increasing the competitiveness of higher education and investment in HC, education, R&D and human resources [Chen, Hu, 2021; Chen, Liu, 2021; Jangraiz, 2015; Lavrikova et al., 2018; Lucas, 1988; Mankiw et al., 1992; Molchanova, Drozdova, 2019].

The Address of President Putin on 29 February 2024 informed the Federal Assembly of the priorities to be set in accordance with the new national project entitled Data Economy, whose priorities include the digital development of science, education, and the country's economy. These key factors and ways forward have determined the authors' approach to analysis in this study. Using the open-source program Replit[9] and the structured, object-oriented programming language Python[10] supplemented by artificial intelligence components, calculations employing a parametric statistical method were carried out for a subset of the components of domestic higher education. This handling of the data enabled detection of the presence or absence of a linear relationship between several quantitative indicators, as well as an assessment of their correlation and statistical significance. Among the automation elements included in the ecosystem of the software code generated by Replit's developer are components that suppress endogeneity and multimodality in complex calculations, as well as the Pearson correlation coefficient formula presented below**:**

$$r_{xy} = \frac{\sum\left(d_x \times d_y\right)}{\sqrt{\left(\sum d_x^2 \times \sum d_y^2\right)}},$$

where x and y are correlated series, r_{xy} is the correlation coefficient, d_y, d_x are deviations of each of the numbers of these.

[9] Replit online environment for developing programs and projects. https://replit.com/.
[10] Python high level programming language. https://python.org.

The result of the software calculation was a Pearson correlation heatmap in Python. In keeping with the research goal and hypothesis, only data from the RF indicators were used in the heatmap. The software is not intended to produce a document; instead it provides a visualized representation in the form of a screenshot of the digital code derived from the data processed. This automated digital processing generated heatmaps of the correlation between the indicators, which appear in section 4 below. The map indicated the degree of correlation between the factors affecting a resulting characteristic. If the correlation coefficient is above 0.8, then a positive relationship between the factors is confirmed.

In addition, limiting the number of characters to indicate tabular indicators led to their reduction in the Pearson heat map. The indicators presented on the left side of the heat map are analyzed along the horizontal axis, taking into account the values of other indicators in the study.

It is beyond the scope of this study to fully assess the three countries using this method. The heatmap data will reflect correlations only across the RF, a scope which is determined by the hypothesis and context of the work.

3. Increasing a country's competitiveness through program and design mechanisms in higher education

Brief overview of programs and projects for the development of higher education in India and China

Despite the publicized disagreements and tensions in the BRICS group between the RI and PRC, trade relations among them were on the rise in 2022, as is indicated by annual trade turnover figures of USD 200 billion. The success of this interaction is partly due to the introduction of a program and project approach to developing higher education at the state level [Hooijmaaijers, 2022]. Table 3 below shows some of the programs and projects at the PRC and RI national level.

The 5–100 and Priority 2030 initiatives as a factor in the development of higher education in the Russian Federation

Deliberate increases in targeted funding for domestic universities have a significant positive impact on their research productivity [Kovalev et al., 2022].

Table 3

Some Key National Programs and Projects for the Development of Higher Education in Effect During 2022 in China and the Republic of India

Country	National projects and development programs	Purpose
RI	NEP 2030	Main program for the development of science and higher education through 2030
	Mpifil	Program for the development of postgraduate studies and science through 2030
	Swatchbharat	Support for higher education infrastructure
	Rashtriya Uchchattar Shiksha Abhiyan	University financial support program for simultaneous study at two universities in master's and postgraduate programs
	Digital India	Digitalization program including higher education
	Wikieducation India	Five-year development plan for higher education.
PRC	Torch	Program encouraging cooperation between enterprises and universities for the implementation of innovative solutions
	Program 863	Program to develop a generation of personnel to work in high-tech fields
	Program 973	Program for the development of postgraduate studies and scientific personnel
	Key Technologies of Science	Project for modernization and financing of university infrastructure to meet the demands of 6 STP
	100 Talents per Year	Targeted project of graduate student grants of USD 240,000
	Innovation 2030	University-based training of young graduates for innovative teams in the country's leading technological enterprises
	Project 985	Creation of 39 world-class universities in science and technology by 2030
	Double First Class Project	Enhancing competitiveness at 465 universities through 2049
	Project 211	Targeted funding program for 112 universities.
	Scientific and Technical Program for the Development of Universities	Promoting innovative development at 500 universities in the country through 2035

Source: author's compilation from the following websites: National Bureau of Statistics of China: http://www.stats.gov.cn; Indian Government Press Information Bureau: https://www.education.gov.in; Ministry of Education of China: http://en.moe.gov.cn/; Ministry of Education of China. Statistical Bulletin of the Implementation of the National Education Foundation: http://www.moe.gov.cn.

To increase the competitiveness of universities in the RF, Project 5–100[11] and the Priority 2030 GP[12] were implemented and have resulted in impressive amounts of targeted funding.

[11] Decree of the Government of the Russian Federation no. 211 dated 16 March 2013 "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" (with amendments and additions). *Compendium of the Legislation of the Russian Federation*, no. 12, 2013, p. 1314.

[12] Decree of the Government of the Russian Federation no. 729 dated 13 May 2021 "On measures to implement the Priority 2030 strategic academic leadership program." *Compendium of the Legislation of the Russian Federation*, no. 22, 2021, p. 3823.

Examination of Table 4 makes clear that the developers of the Project 5–100 took into account neither the way international institutional ratings are constructed nor the distinctive features of the RF's higher education system. There is also an imbalance in funding between the three tiers of universities funded by the project.

This suggests that program and project management mechanisms in higher education are still in the process of formation. Although the most important shortcomings of Project 5–100 readily come to the fore when evaluating it, they can draw attention away from certain more significant and interesting features of the project. Even though the Project 5–100 universities had not reached the top 100 international institutional rankings at completion of the project, they were

Table 4

Comparison of Project 5–100 and GP Priority 2030 in the Russian Federation

Project 5–100	GP Priority 2030
Financing	
Allocated 80.1 billion rubles to 21 universities over seven years.	Each university will receive 100 million rubles annually through 2030; an additional Research Track provides up to 1 billion rubles; the Industry Track offers 85 million rubles. Total financing in 2022 came to 27 billion rubles and in 2023 to 32 billion rubles.
Goals and objectives	
A uniform system of indicators is to be tracked at 21 universities while they pursue becoming one of the top 100 leading universities in the world of any kind and also ensure the growth of external academic mobility. The universities in Project 5–100 are divided into three groups depending on their scientific and educational activities. The total funding that universities of the first group received for scientific research and publications in WoS and Scopus was 6 to 7 times higher than the state support provided to universities of the third group.[a]	Covered 132 universities in 2023 with the objective of transforming over 100 modern universities into centers of scientific and technological development for the RF. Academic mobility programs for academic staff and students within the country are to be implemented. The program refers to six tracks, each of which has a different set of indicators and goals and rotates among participating universities.
Impact of regulations and changes to them on the projects	
PD no. 599 dated 5 July 2012 established Project 5–100, but the requirements and criteria for assessing the quality of education have not been sufficiently specified; chaotic interaction between stakeholders, uneven funding, and unplanned changes in indicators in 2015, 2016 and 2018 have also held Project 5–100 back.	Close relationship and integration with: PD no. 143 dated 15 March 2021, PD 474 dated 21 July 2020, the Science and Digital Economy NPs, and the Federal Projects (FPs) entitled "Development of integration processes in science, higher education and industry" and "Personnel for the digital economy." This integrated approach positions all aspects and processes of the program in a system and thus frees universities to focus on their trajectory for development.

Remainder of Table 4

Project 5–100	GP Priority 2030
Results	
The number of joint research projects of participating universities with the Russian Academy of Sciences increased by 23%, while the number of publications appearing in WoS and Scopus from the participating universities increased 3.5 times; over ⅔ of these publications were in journals published in Q1 and Q2. A total of 224,520 publications from all the participating universities appeared in Scopus and WoS. Over a seven-year period, the project's participants contributed to an increase from 19.7 to 47.7% in the Q1 percentage of Russian universities' publications in the journals included in Scopus and WoS. The total number of R&D projects was 2,083 (an 11-fold increase). In 2017, 14 participating universities were granted the right to award their own academic degrees. In 2019, each of the participants invested an average of 1.5 billion rubles in R&D. The average Unified State Exam score of applicants accepted for state-financed positions increased from 76 to 82 points, a score 12 points higher than the national average. The share of young teaching staff (up to age 39) at participating universities has doubled, while the share of foreign students increased 2.6 times, graduate students 2.4 times, and the share of foreign teaching staff doubled. Every sixth postgraduate student in the country studies at a Project 5–100 university. Only four Russian universities appeared in the QS, THE and ARWU worldwide university ratings in 2012, but by 2020 that number had risen to 27.	A group of researchers found that there was relatively little spread among all universities in their basic indicators [Guseva et al., 2023; Lavrinenko, 2023]. According to Minister V. N. Falkov's report, there was a 57.1% increase in the availability of high-quality higher education and a 20% increase in the number of dissertations defended by graduate students at universities participating in the project.[b] The problems of technology transfer and commercialization are the first to be solved, and that progress will encourage an increase in R&D activity and in income produced by intellectual efforts along with an increase in the number of publications. Because Priority 2030 extends to roughly six times more universities than Project 5–100 and has greater geographic coverage, Priority 2030 will promote academic mobility within Russia and stimulate research projects that benefit the state and thus will have a positive effect on the entire higher education system of the RF. This comprehensive coverage will help even out development among different areas of the state, improve the scientific and publication activity of universities, and ensure the availability of high-quality higher education in all the regions of the RF.

[a] *The Accounts Chamber assessed the effectiveness of the university's Project 5–100* (2021). https://ach.gov.ru/news/schetnaya-palata-proekt-5100-zadal-novye-napravleniya-razvitiya-vysshego-obrazovaniya-no-ne-dostig-p?ysclid=lt022bwfwv892870209.

[b] Falkov V. N. *Final report for 2022*. Ministry of Education and Science of the Russian Federation. https://minobrnauki.gov.ru/press-center/news/novosti-ministerstva/68131/.

Source: authors' compilation from the following websites: https://5top100.ru/; https://minobrnauki.gov.ru/action/priority2030/; https://minobrnauki.gov.ru; minobrnauki.gov.ru/documents/?ELEMENT_ID=40696&sphrase_id=8077777; https://clarivate.com/; https://www.scival.com/; http://www.shanghairanking.com; https://www.timeshighereducation.com/; https://www.topuniversities.com/.

able to achieve the significant results reflected in Table 4, and 19 out of 21 universities became participants in the GP Priority 2030. In general terms, analyzing Project 5–100 and GP Priority 2030 reinforces the idea that the higher education system has a "soft power" effect on the current state of science.

Financial resources, limitations, and the potential of Russian higher education

Tables 3 and 4 indicate that strengthening technological sovereignty and adding to the number of programs and projects for the development of higher education in the RF are clearly insufficient for reaching the goals of the STTD and mastering 6 STP technologies. This intermediate conclusion is consistent with the research hypothesis. However, two important aspects affecting financial resources should also be noted.

First, despite the global challenges faced by the RF, the President announced three national projects — Personnel, Data Economy and Youth — which will strengthen and expand funding. Additional measures under these programs will be aimed at training one million highly qualified specialists for innovative enterprises by 2030. Such program and project measures will increase the competitiveness of higher education.

Second, in the section immediately above it was shown that only 303 universities out of the RF's 1,247 universities submitted applications for the GP Priority 2030, and only 187 of those applications were eligible for consideration. At the time of writing, the program included 142 participating universities. Although each state university received official notification from the Ministry of Science and Higher Education, only 24.2% of universities in the RF submitted applications, yet only 67.1% of those applications qualified for consideration. Under the terms of the GP Priority 2030, each university is to present its existing competitive advantages in personnel and also propose the ways in which it will increase human capital and build out an effective university development program. Some of the main formal indicators used to evaluate a university's capacities based on its application are presented in Table 5.

Table 5

Key Indicators for Assessing a Project Application for the GP Priority 2030

Indicator	Value
Enrollment of full-time students	≥ 4,000
Total annual financial support for the university	≥ RUB 1 bln
Percentage of funds received by the university from local sources (the immediate region or constituent administrative district of the RF and the municipality)	≥ 1%
Teaching staff under age 39 as a percentage of the total number of teachers without external part-time work	≥ 15%
Percentage of postgraduate students who defended their dissertation within the previous year	≥ 1,4%
Number of publications in Scopus and WoS over the previous three years as a ratio of the total number of teachers	≥ 0.08
Indicative university assessment performed	within the past 5 years
Percentage of teaching staff with scientific degrees	≥ 76%

Source: compiled by the authors from materials at https://sociocenter.info/.

It is impossible to categorically exclude the hypotheses that the increase in the competitiveness of a certain group of universities occurred because of backsliding in certain sectors of the national higher education system. Nevertheless, the number of universities that submitted applications for Priority 2030 and the percentage of eligibility for consideration may indicate that there is some degree of crisis in university management. Although many universities struggle to secure sufficient financial resources, for various reasons the management of a majority of universities could not seize the opportunity to receive 100 million rubles annually and a chance to win the program's annual special grant of 1 billion rubles. Unlike Project 5–100, successful applications to the Priority 2030 program require a recent indicative assessment which is a report delivered to the Ministry of Science and Higher Education in its capacity as founder of the universities and to the expert council for Priority 2030. The university's certified performance indicators for the previous five years and the university's detailed development strategy through 2030 are also to be included.

The scope of this study does not extend to granular evaluation of the activities and condition of universities over the past five years, or to the rankings and indicators of universities, or to the specifics of each university that submitted an application. Such an evaluation of strategies and conditions at universities would require a separate article, and in any case publicly accessible data for such research can be obtained from the websites of the universities.

It should, however, be noted that the order of the President of the RF PO-58906022020 has established that, if a university's management proves incapable of creating innovative tools which increase competitiveness and encourage flexibility of thinking in order to build a world-class university model and which make R&D an integral and commercialized part of the educational activities of teachers and students, then that shortcoming will result in the reorganization of such universities by 2030. Furthermore, their students will be guaranteed the right to complete their studies at other universities. This transition from relatively closed and simplified criteria for distribution of financial resources from the state is aimed at strategically increasing the competitiveness of higher education and of the country as a whole. Another advantage of this approach is that six times more universities can benefit from the Priority 2030 program than from Project 5–100.

The President of the RF has also announced three more national projects aimed at the development of higher education, although the budget for them is still to be determined. At the time of this study, government funding of the Science and Universities national project amounted to 871 billion rubles, and another similar amount will be provided through 2030.

These various initiatives make it safe to conclude that financial resources and new projects at this stage are sufficient for the development of competition in higher education because a substantial number of universities did not have the capacity to devise strategies that contain clear mechanisms and resources, indicators, and suitable goals, and also supplement these with a program for the development of their HR. For that category of universities, it follows that the problem lies with the university's management. Nevertheless, given the current challenges facing the RF and the empirical analysis carried out here (see Tables 3, 4, 7 and 8), addressing the general issues of competitiveness and optimization of the internal higher education system can be deferred for a time.

At some later date, a systematic 4- to 5-fold increase in spending on education and R&D will be required in order to match India's performance indicators for its higher education system. Drawing equal to the PRC's positioning would require a 15 to 20 times increase in spending, which seems completely unrealistic. Table 6 is an attempt to present the funding required in the future to match the performance of the RF's higher education system in terms of the RI's targets.

Table 6

Roadmap for Financing Higher Education Projects in the RF in Order to Match the RI's Performance

RI target category	Amount of financial support by year of implementation (RUB bln)						Federal budget, total (RUB thsnd)
	2025	2026	2027	2028	2029	2030	
Comparable title for program and project tools							
Campus technological infrastructure	0.4	0.5	0.6	0.7	1.1	1.3	4,600,000
Development of HC taking into account SSTD and the needs of the regions	0.3	0.4	0.5	0.6	0.7	0.5	2,500,000
Total							7,100 000
Comparable indicator							
Ranking of the RF in terms of R&D output in the OECD	18	18	17	16	12	10	
Teachers under age 39 with a scientific degree (thsnd)	101.8	111.0	120.2	150.0	200.1	400.2	

Source: compiled by the authors from research materials.

Recommendations for higher education in the RF

The authors' theoretical review disclosed a number of factors that were overlooked by the academic community but were clearly established in Government Decree (GD) no. 1288 "Concerning project activities" (superseding no. 1019 and 987) and Federal Law no. 172 "On

strategic planning in the RF." Also noted were fragmentation of the proposed measures, as well as lack of a modern approach to defining the "competitiveness of a university" and of models of the relationship between the country's competitiveness and its universities as they impinge upon project activities.

The problems identified among domestic universities can be converted into areas for growth, provided that the university initiates a regional and/or municipal project of its own, which will integrate it into the system for public administration and financing and enhance coordination with national and federal projects and with state programs; that integration should ensure the involvement of all its key stakeholders and the accumulation of resources for a university that initiates such a project.

The recommended steps for universities fall into three broad areas, as follows:

1) Each university must address these problems individually through a regional or municipal project carried out as part of project activities which, in accordance with GD no. 1288, will specify the actions required of project development participants with a common goal, the methods agreed upon for achieving the final result, and a justified rationale presented in the project's certifying documentation and which must follow certain structural requirements. From an administrative point of view, the project should be based on the core of the regulatory framework. Therefore, a project is a temporary undertaking which produces a document formed according to a certain algorithm in order to solve a problem existing in society. The undertaking includes a set of activities, a budget, and risk assessment. It has stakeholders responsible for the results, preparing a road map, and meeting the requirements laid down in legal acts, which provide a legislative and financial basis at the state level to assist in creating a unique product or outcome.[13] The project must be compatible with the STTD, the geographical development strategy of the RF, the projections for socio-economic development of the RF and the project's own region, national and federal projects, and the state program of the RF and the project's region.
2) Universities need to reconsider their previous thinking about the competitiveness of a university and use the authors' definition, which differs from earlier attempts by focusing on the management of an educational organization in the following ways:

[13] State Standard: GOST 58305-2018; ISO 21500:2014; GD no. 1288 "On project activities;" GOST 58184-2018.

a) establishing the university as a key participant in ensuring the competitiveness of education and the technological sovereignty of the RF;
b) emphasizing modern, innovative tools for public administration in accordance with the Decree of the Government of the RF no. 1288 (superseding no. 1019 and 987) "On project activities in government agencies,"[14] Federal Law no. 172 "On strategic planning in the RF" and the relevance of SSTD,[15] which is the central document of the country's strategic development;
c) foregrounding the university's capacity for responding to the needs of stakeholders and attracting resources;
d) tracking the university's rankings and using indicators from the authors' extensive ongoing work in this field to evaluate results and to increase the competitiveness of the university.

3) The structure of the university clearly needs to change, and one of the options could be creation of a project office. A problem tree and goals for the university should first be laid out. The second step would be to state the main goal of the university with due consideration of the guidelines for "smart" functioning. Various tasks should be defined and structured in accordance with "smart" approaches as the third step, and each task should be assigned a "weight." The fourth step would be to draw up a plan of program activities for each task and outline the schedule and scale of its implementation. At the fifth step, an indicator should be devised for each program activity together with a specification of its baseline, annual, and final values to be used as goalposts for monitoring. Sixth, a quarterly monitoring system should be incorporated into the university structure for the purpose of indicative assessment and evaluating the degree of impact, implementation of activities, and progress toward goals and objectives. Thus, program measures for project implementation consist of six key stages, each of which has its own content, is carried out in a definite and logical sequence, and has its own structure. Using these measures would contribute to forming and monitoring the intellectual capital of a university, as well as to the organization of methodological support with emphasis on practical application.

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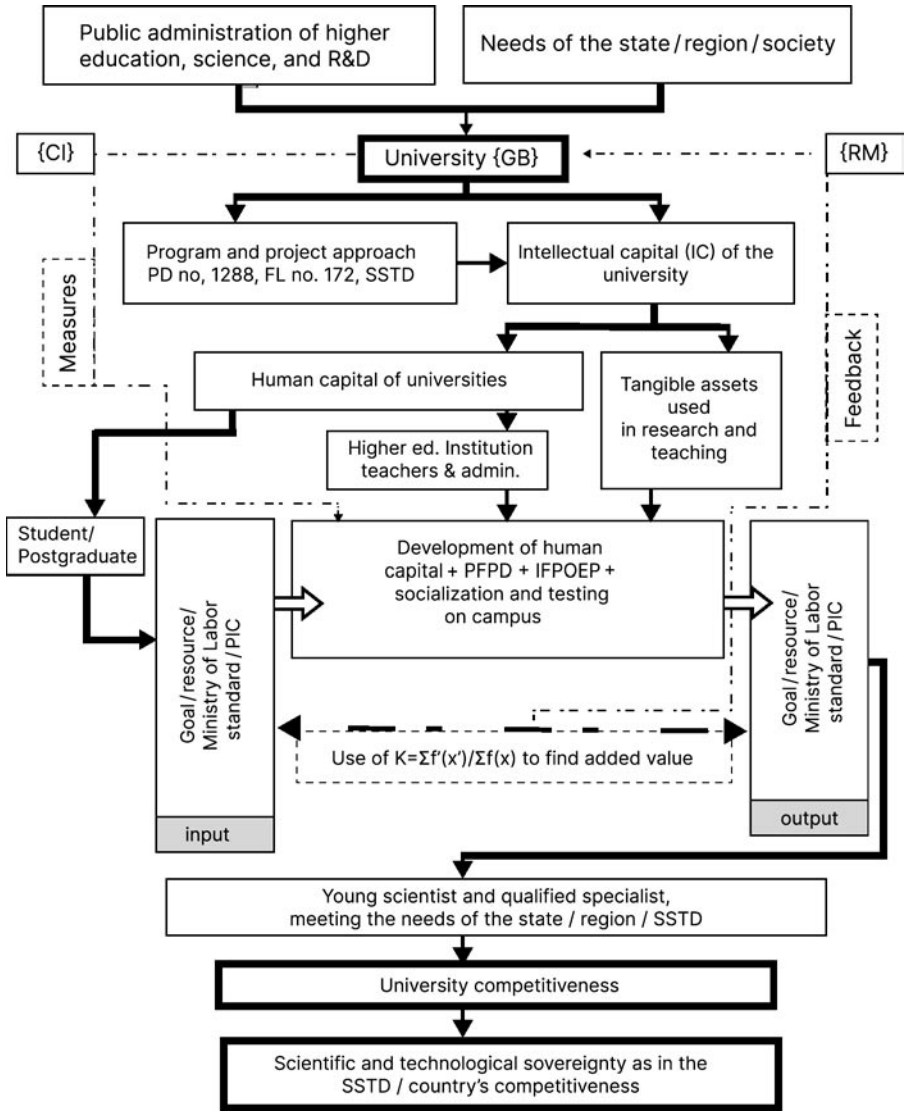
[14] Federal Law "On amendments to the Decree of the Government of the Russian Federation no. 1288 dated 31 October 2018" and Resolution of the Government of the Russian Federation no. 987 dated 24 June 2021 "On amendments to the Decree of the Government of the Russian Federation dated 31 October 2018 no. 1288" and Decree of the Government of the Russian Federation no. 1019 dated 10 July 2020. *Compendium of the Legislation of the Russian Federation*, no. 27, 24 June 2021, p. 5375.

[15] Federal Law no. 172-FL dated 28 June 2014 "On strategic planning in the Russian Federation (as amended on 17 February 2023)." *Compendium of the Legislation of the Russian Federation*, no. 26 (Part 1), 2014, p. 3378.

4) The project should use the authors' model (see Fig. 1 below), which is based on theoretical research and whose central idea is to ensure the technological sovereignty of the RF by expanding high-quality HC, an improvement which will be made possible as the competitiveness of higher education is upgraded with the help of better program and project management. A project of this kind was prepared by the authors using an algorithm compliant with GOST ISO 21500, 58184 and 54869, Federal Law no. 172 and GD no. 1288 (superseding no. 1019 and 987). It incorporates a set of individual indicators for all stages of a project's life cycle and enables thorough monitoring. It has been partially evaluated in other publications and is currently under consideration at the project office of a regional ministry.

Using the model is intended to bring about a higher education system that is designed to meet the needs of the state and its region, readily align with the key documents of the country's strategic development as well as comply with PD no. 145, 309 and 343 and respond to the challenges that have been encountered by the country. Indicators based on the distinctive features of a university are identified and used to assess its competitiveness; these indicators must be individualized, a requirement which follows from the different positions in national and international rankings that the universities occupy. The model will highlight the components of ratings that require improvement in comparison to a university's competitors. The introduction of this new approach to managing the university's structure will result in expansion of its HC with respect to development of innovative, flexible, practice-oriented educational programs (IFPOEP) and programs for professional disciplines (PFPD), ensuring adherence to the SSTD and upgrading the quality of administrative management.

Within the framework of the classical theory, the IC of a university in the sense intended here includes its intangible assets that are used in teaching and research, an important part of which is the HC involved in higher education. HC consists of students, teaching staff, and administrative personnel. From the viewpoint of scientific and technological progress, the main output of a modern university required to take advantage of the 6 STP is a young scientist who is a competitive specialist and meets the current needs of the country, region, and specific organizations in the labor markets and who is able to create innovative products that are in demand in the society. Target indicators, university resources, the number of program and design measures, and the professionally important competencies (PIC) that students should acquire are among the "inputs." At that stage the student does not yet have professionally important competencies (Fig. 1) that meet the stand-



Source: developed by the authors.

Fig. 1. **Model of the Relationship Between the SSTD and the Competitiveness of Universities in the Russian Federation**

ards of the Ministry of Labor. Using a functional equation expressing the relationship between the values of the function at different points $K = \Sigma f'(x') / \Sigma f(x)$ yields a basic calculation of the number of program and design measures at the university and the competencies of students at the entrance to and exit from the educational program. The students who emerge as "outputs" will have reached a new level of professionally important competencies in their respective specializations. These PIC will conform to the standards of the Ministry of Labor and will be

taught through practical study that, at a competitive university, benefits from modern, innovative management, IFPOEP, and PFPD. Students' PIC will be a principal asset for them when they enter the labor market. Determining PIC at input and output, target indicators, university resources, as well as the number of program and design measures is a prerequisite for applying the model. The assessment process and its results then operate as a feedback loop for the regulation of management (RM in Fig. 1) by the university's governing body (GB) in order to ensure the flexibility of the IFPOEP and PFPD. The system for monitoring and measuring indicators at the input and output stages offers a way to guide and control inputs (CI), IC, IFPOEP, and PFPD. The program measures in the model will increase the competitiveness of a university and make its pursuit of effectiveness evident and transparent. The Ministry of Education and Science of the RF will therefore view that university favorably when it comes to including it in government projects and programs for the development of higher education, all the more so because strategic planning tools have been applied and an indicative assessment the development of the university and of its IC and HC has been carried out. The model presented in Figure 1 is suitable for regional or municipal projects aimed at increasing competitiveness as confirmed by an indicative evaluation which is initiated by the universities or regional government authorities and which conforms to PD no. 145, 309 and 343 while taking into account the research hypothesis.

4. Empirical study of key components of scientific and technological development and of education systems

Table 5 displays an indicative matrix of investment in key individual sectors of the knowledge economy and in the development of HC. Such investment can be indicative of a country's relative competitiveness. The empirical part of this study was conducted at the end of Q4 of 2023. Data are presented for 2022, because information from various international institutions and the relevant government bodies of the three countries is published at different times. In addition, the information security arrangements of the RI and the PRC allowed access to information only through a virtual private network (VPN). The indicative matrix (Table 5 below) presents the combined data of key international institutions for a cost-based assessment of relative competitiveness. It should be noted that in response to the Special Military Operation (SMO), the International Organization for Economic Cooperation and Development (OECD) on 3 August 2022 announced that negotiations on the RF's accession were terminated, that publication of statistics was curtailed, and that its Moscow office was closed and would not provide

further data. These restrictions also played a part in determining the date of the last ranking of countries in higher education.

Table 7

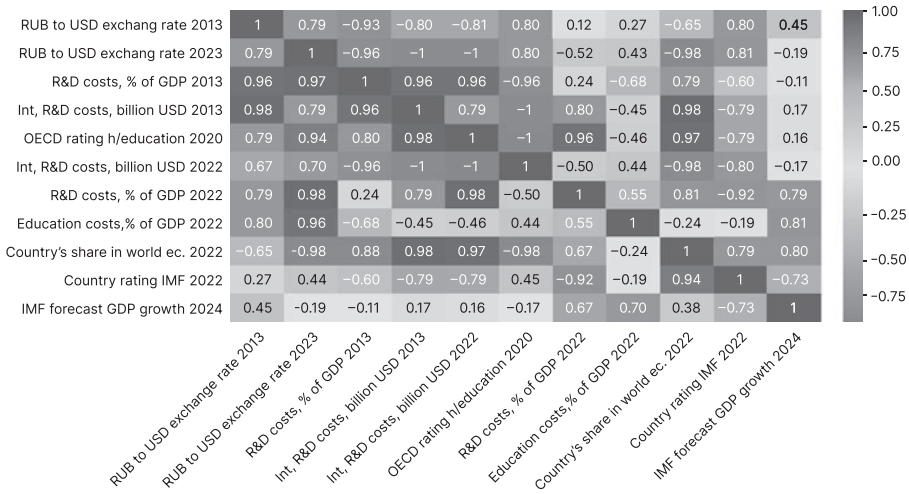
Comparison of the Cost of Investing in the Knowledge Economy Categories of R&D and Education in the RF, PRC and RI

Country	National exchange rate to dollar (USD)	Domestic R&D costs (% of GDP)	Internal R&D costs (USD bln)		Domestic R&D costs (% of GDP)	OECD rating for higher education	Education costs (% of GDP)	Country's share in total (USD 164.1 trn) world economy	IMF country rating	IMF forecast for GDP growth
	2013/ 2022	2013	2013	2022	2022	2020/ 2013	2022	2022	2022/ 2013	2024
PRC	6.09/7.1	2.06	290.3	554.3	2.4	31/89	4	31.6	2/3	4.2
RI	61.3/83.3	0.69	42.8	68.2	2.5	44/96	4.1	12.5	5/10	6.3
RF	30.9/91	1	24.8	40.1	1	45/31	4	5	11/8	1.1

Source: authors' compilation from the following websites: https://uis.unesco.org; https://www.un.org/ru/desa; https://www.worldometers.info/world-population/india-population/; https://www.imf.org; https://data.worldbank.org; https://www.undp.org; https://www.oecd-ilibrary.org/education/; https://www.wipo.int; https://uis.unesco.org; https://hdr.undp.org/data-center/country-insights#/ranks; ww.undp.org/sites/g/files/zskgke326/files/migration/arabstates/GKI; www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2022-en-main-report-global-innovation-index-2022; https://cbr.ru/; http://www.stats.gov.cn/; https://www.meity.gov.in; https://rosstat.gov.ru/.

The data in Table 7 supports the following observations. The RF has lost 12 places in the OECD education ranking. Over nine years, the RF has increased its allocation to R&D in absolute terms by 61.7%, the RI by 59.3%, and the PRC by 90%. However, a deeper analysis of this data would find the apparent significant tapering off of higher education investment in the RF is partly due to the weighted average annual exchange rate of national currencies of countries relative to the US dollar, as devaluation against it varied widely among the three countries. The exchange rates of RI and PRC over nine years were devalued by an average of 16% in USD terms. Over the same period, the Russian national currency was devalued by 300%.

Using data from the Central Bank of the RF, the inflation rate was calculated on an annualized basis from 2013 to 2022 as the sum of the inflation rates for each month, a method which revealed variations masked by measuring the inflation rate as a whole and smoothed out seasonal deviations. The resulting rate of inflation mirrors the increase in R&D funding. Inflation in the RF amounted to 78.3% over the nine years considered, and it follows that RF expenditures on R&D held steady at the 2013 level.



Source: compiled by the authors using Replit, Python, and artificial intelligence.

Fig. 2. **Pearson Correlation Heatmap Derived From Table 7**

In addition, limiting the number of characters to indicate tabular indicators led to their reduction in the Pearson heat map. The indicators presented on the left side of the heat map are analyzed along the horizontal axis, taking into account the values of other indicators in the study.

A close correlation between several indicators emerged in the heatmap. This includes domestic R&D expenditures in billions of US dollars, domestic R&D expenditures as a percentage of GDP, education expenditures as a percentage of GDP, and the effect of national currency exchange rates on these indicators. In addition, a country's share in the global economy is heavily dependent on the amount of investment in R&D in billions of US dollars, which is in turn a factor in the rating by the International Monetary Fund. Analysis revealed areas in which the RF falls short: its investment in R&D is 1.7 times less than in the RI and 14 times less than in the PRC. In terms of US dollars, the RF's investment in education is 6.5 times less than the RI's and 17 times less than the PRC's.

The scientific and technological development of a country relies on its HC in higher education. Factors relevant to understanding the condition of HC at institutions of higher education in the RF, PRC and RI are presented below in Table 8, which does not include RI nationality students (0.5% of all RI students) and PRC students (0.9% of total students there) who are enrolled in academic mobility programs that take them abroad.

The number of students in the RF became 1.9 times less over fourteen years, while the student population in the RI increased 3.2 times

Table 8

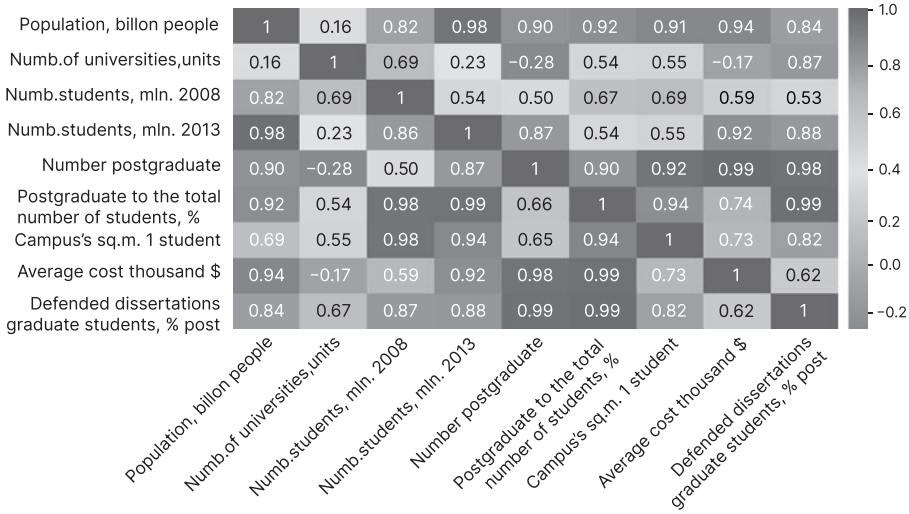
HC Resources for the Development of Higher Education and Science for 2022 in the RI, PRC, and RF

Country	Population (bln)	Number of universities	Number of students (mln)	Postgraduate students (thsnd)	Ratio of postgraduate students to total students (%)	Campus area per student (sq. m.)	Defended dissertations of postgraduate students (%)	Average annual cost of full-time higher education (USD thsnd)
	2022	2022	2008/ 2022	2022	2022	2022	2022	2022
PRC	1.425	1,489	20.21/ 44.32	1,242.2	6.9	51.6	14.6	3,228
RI	1.433	1,113	13.04/ 41.38	2,114.1	5.2	33.8	7.5	3,988
RF	0.146	1,247	7.513/ 4.076	109.7	2.6	8.2	1.4	1,741

Source: authors' calculations from the following websites: https://rosstat.gov.ru/statistics/science; http://www.stats.gov.cn; https://www.statista.com; https://www.meity.gov.in/content/stpi; https://www.education.gov.in; http://www.moe.gov.cn; https://ruralindiaonline.org/en/library; https://www.un.org/ru/des; http://en.moe.gov.cn/; https://data.worldbank.org/; https://uis.unesco.org; https://.nirfindia.org.

and 2.2 times in the PRC. The number of postgraduate students in the RF is 11 times less than in the PRC and 22 times less than in the RI. These variations in the number of students and postgraduate students in the RF and in the quality of training they receive are not conducive to reaching the goals set out in the SSTD and the Address of the President of RF. Reaching them would require the state and universities to undertake separate initiatives, some of which are formulated in the research hypothesis.

Young scientific personnel are drivers of the country's future development. Analysis here has established that the number of graduate students correlates tightly with the percentage of dissertations defended, the average price of tuition, and the area per student at university campuses. The importance of these factors is confirmed by the statistics in Table 8. For example, the number of defended dissertations as a percentage of the number of students in the RF is 7 times less than in the RI and 14 times less than in the PRC.



Source: compiled by the authors using Replit, Python, and artificial intelligence.

Fig. 3. **Pearson Correlation Heatmap Derived From Table 8**

5. Research Results and Main Conclusions

In accordance with the SSTD (PD no. 642 dated 1 December 2016, PD no. 143 dated 15 March 2021, and PD no. 145 dated 18 February 2024), the strategic goal of state policy with regard to higher education and science is "ensuring world-class R&D, global competitiveness, and the technological sovereignty of the country by 2035." However, this study found that, despite clearly identified priorities, scientific and technological development in the RF is progressing at a noticeably slower pace than in the world's leading economies, and this differential in progress is a principal problem for the RF. This has been confirmed in the UN Global Innovation Index for 2023 where the RF placed 51st, a loss of eight places in the seven years since the publication of the first SSTD in PD no. 642.

Universities and government bodies can use the results obtained in this study as the basis for their calculations when developing methodological provisions and tools that will strengthen the potential of higher education in the RF and secure the country's technological sovereignty. Among the research results suitable for upgrading higher education are the following:

1. Comparison of Project 5–100 and the Priority 2030 program established that the latter program will allow six times more universities to participate and thus benefit from comprehensive development and strengthen the research components of the university model in order to adhere to the SSTD. However, when comparing

the number of programs and projects at the national level in the three countries studied, it became obvious that domestic higher education requires developing a wide network of program and project initiatives.

2. A comparison of indicative assessments of the state of the educational systems under study showed that the higher education system of the RF trails behind that of the PRC and the RI (Tables 7 and 8). These negative trends in the RF higher education system impair the country's technological sovereignty and threaten its security.
3. Two problems in the RF's higher education system have been identified: weak compliance by universities with the country's strategic development documents; and lack of the knowledge and skills to apply program and project management as prescribed by Federal Law no. 172 "On strategic planning in the RF."
4. Analysis of statistical data on the financing needed to fulfill the SSTD indicates that investment in R&D, science, and higher education must increase many times. Comparison of the three countries covered in Tables 7 and 8 by means of heatmaps showed that the amount of funding devoted to higher education is directly proportional to higher values for the parameters of a country's innovative development. The limited contingent of HC engaged in higher education requires higher quality training in higher education techniques and postgraduate programs as well as improved conditions for learning.
5. The systemic and structural analysis that was conducted of the state and degree of development in higher education allowed the authors to evaluate the potential for innovative development in the RF compared to other countries. Realizing that potential involves developing tools for innovative development that reach all of the RF's constituent administrative districts through regional and municipal projects to increase the competitiveness of local universities.
6. Scientific innovation is tightly bound to the concept of the competitiveness of universities, which should be understood as a system with components and elements that ensure the innovative advancement of a university in the domestic and international market for educational services while also taking into account the country's guidelines for strategic planning, program and project management and for ensuring sovereignty.
7. Scientific innovation is now anticipated through application of a cybernetic model of systemic management for the process of increasing the competitiveness of a university; and this approach is also closely connected to current research trends in program and

project management, which demand accelerated implementation in the RF higher education system to ensure adherence to the SSTD (PD no. 145) and can be used in regional and municipal higher education development projects.

8. The program measures for strategic development of domestic universities, formulated in the authors' recommendations employ an algorithm that includes a logical sequence consisting of six sections, each of which has stages that have their own structure with respect to substance and content and which unfold in a strict sequence. Strategic planning of that nature ensures the achievement of the strategic goals of increasing the competitiveness of any university in the RF.
9. The data obtained from statistical, systemic, and structural analysis supplemented by observation of participants confirm the research hypothesis, which is based on the SSTD PD no. 145 and the Address of the President of RF to the Federal Assembly dated 29 February 2024 and which maintains that the implementation of the SSTD will increase the competitiveness and sovereignty of the RF. The research hypothesis also reaffirms the scientific and practical significance built into the two new national projects — Personnel and Youth. The training of one million highly qualified specialists for domestic enterprises that are mastering 6 STP technologies in response to program and design measures implemented by the authorities will likewise ensure increased competitiveness for the RF's higher education system while buttressing the sovereignty and independence of the RF.

Conclusion

The RF has not yet developed a comprehensive system of strategic planning for the development of higher education, and adoption of a program-targeted approach in universities is still not widespread. One indirect sign of this deficiency is the lack of a comprehensive strategy for the socio-economic development of the country which would include higher education. Even after taking into account the current regulatory and legal framework, the progress toward increasing the competitiveness of higher education by using program and design measures remains extremely low. This study underlines the significant and growing gap between the three countries. The adoption of PD no. 145, 343 and 309 indicates a change in the dynamics and structure of the RF's demands on technological and knowledge-intensive industries. The initiation of the two new national projects — Personnel and Youth — as well as the implementation of Priority 2030 highlights the need to rectify the imbalance in the training of scientific and highly qualified

personnel and stimulate innovation in the domestic economy for the development of technologies that are part of the 6 STP.

Higher education in the Russian Federation is increasing the role of a program- and design-based innovative approach to the strategic development of universities because accelerated economic restructuring toward the 6 STP is needed in response to sanctions.

Initiating regional and municipal projects at universities with national status in the RF and also at local universities serving the country's various constituent administrative districts while also adopting the model proposed here would enable university management to focus on the key goals and needs of the state in response to sanctions by applying relevant and innovative tools. The model is built on an updated understanding of a university's competitiveness, and it facilitates management of the process that a university uses to increase its competitiveness. This approach will lead to an increase in the competitiveness of the country's higher education, which will correspond to the goals and objectives in the Address of the President of RF to the Federal Assembly dated 29 February 2024 and PD no. 145, 343 and 309.

The scientific contribution to the article by the Chinese author amounted to approximately 15% and consists mostly of Chinese statistical data and of passages that refer directly to the Chinese authors in the literature. The Russian author is responsible for 85% of the research and 100% of the original content (scientific innovation).

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