Five Crises of Human Capital: A Pathway to Achieving Socio-economic Parity with Developed Nations in Russia Today

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Abstract: *Purpose:* This research aims to identify the necessary conditions and reforms for Russia to transition to an innovative development path and attain a socio-economic level comparable to that of developed countries. The research goal is achieved by analyzing the key macroeconomic drivers of scientific and technological development and evaluating public policy, budget priorities, and ongoing reforms from the past 30 years. The research also investigates the "five crises of human capital" and the loss of more than 57% of Russia's scientific and technological potential. Using correlation and comparative analysis methods, the research analyzes the relationship between economic growth rates, high-tech production, and human capital. The research establishes that 96% of the dynamics of GDP growth are attributed to investments in technology transfer, the creation of comfortable conditions for attracting and retaining scientific and technological personnel in real sectors of the economy, and not investments in the "knowledge economy." Moreover, the research emphasizes the possibility of a sixth "human capital crisis" and suggests policy and legislative changes necessary for innovative development comparable to developed countries. The author presents an insightful forecast for the necessary scientific and engineering professionals needed to achieve exponential GDP growth until 2040. Additionally, the author emphasizes the importance of policy and legislative changes toward innovative development comparable to developed nations.

Keywords: developing country, economic development, growth, innovation, research, sci-tech, technology

JEL codes: O1, O11, O15, O2, O21, O23, O25, O3, O31, O32, O33, O34, O38, O34

The state (Ministry of Economic Development of the Russian Federation, 2022) and the scientific community (Aganbegyan, 2014) have recently paid increasing attention to issues such as "slowing down the socio-economic development of Russia," including "transitioning Russia's economy from stagnation to development" (Bazanova, 2019), import substitution

(Import substitution in Russia, 2023), structural changes in Russia's economy and exports (Sitnikov, 2020), (Ivanter, 2017), modernization of the country's production and technological base, the potential to achieve different countries' levels of socio-economic development, innovation development in Russia, and the question of how to restart social-economic growth in Russia after the 2020 crisis. The global financial crisis, insufficient investment in fixed capital, and COVID-19 have been blamed for the failed social-economic development strategies in Russia. However, these factors should be considered as "symptoms" rather than as the root causes of problems.

Despite the considerable number of publications on related topics and the coverage of the issue of increasing "investments in the knowledge economy," the issue of the quality of the distribution of investments in R&D as a percentage of GDP between sectors of the economy, the mechanisms of their investment, and the relationship with the number of scientific and engineering specialists have not been sufficiently studied in economics.

Method

The author employs correlation and comparative analysis to investigate the relationship between economic growth rates (based on data from the Federal State Statistics Service of the Russian Federation (Rosstat) and the IMF), particular indicators of high-tech production, the portion of human capital in the economy, and the quality of investment allocation in R&D as a percentage of GDP across various sectors of the economy via ongoing reforms and budget priorities.

Results

The basis of sustainable economic development in developed countries such as China, the USA, Japan, Germany, France, etc., is the production of high–tech products, the share of which is about 15%–25%. In Russia, this indicator is at 6%–9% (Fomichev et al., 2015).

China and India should be recognized first and foremost among the most dynamically developing countries, whose GDP growth has exponentially increased from 1990 to 2021 (IMF, 2022). In contrast, the GDP growth dynamics of the USA, Russia, and other developing countries are described linearly, suggesting that the factors driving the explosive growth of economies in these comparison groups have different characteristics. Therefore, to understand the driving forces behind this growth, it is necessary to focus solely on China and India as benchmarks (Kolomiets, 2023a).

To verify the accuracy of the statements mentioned above, the author suggests analyzing the drivers that serve as the foundation for the production of high-tech products, which form the basis of the GDP of the most rapidly developing countries around the globe, as well as their dynamics within Russia. People (human capital) are the critical component of a high-tech business capable of producing competitive products. The analysis of this driver in terms of the dynamics of scientific R&D in Russia, carried out by Dr. Sci. from 2005 to 2016, shows degradation and regression in the "business sector" for 11 years (Table 1). In other sectors, there is either stagnation or a flow between sectors.

Table 1

Dynamics of the number of employees of organizations that carried out R&D, having a Dr. Sci. degree from 2005 to 2016, and distribution of the number of employees in organizations conducting scientific R&D with a Dr. Sci. degree from 2005 to 2016 by sections

Year	Public sector	Business sector	Higher education	Non-profit organizations sector	Foreign ownership	Joint Russian and foreign ownership	Total by ownership forms
2005	16531	4281	2667	23	4	96	23502
2011	17856	4164	5860	94	6	61	27974
2016	18051	3211	6656	46	12	69	27965
Total by the form of ownership of which by section							
Year	**Total by the form of ownership of which by section**	**Real estate transactions, rental, and provision of services**	**Education**	**Healthcare and provision of social services**	**Provision of other communal, social, and personal services**	**The rest of the real economy**	**The share of Dr. Sci. in the real sector of the economy**
		K	**M**	**N**	**O**	**A, B, C, D, E, F, G, I, H, J, L**	
2006	23990	20786	2726	250	73	155	0.65%
2011	27974	21677	5647	352	114	184	0.66%
2016	27965	20096	6931	479	120	339	1.21%

Source: Developed by the author based on Rosstat (2023a)

The primary growth over a 10-year span, deemed the main “appearance of growth,” occurred in the higher education sector, where the number of research projects conducted by Dr. Sci. increased from 2667 to 6656. However, this expansion had a weak or indirect impact on the ability to boost the production of high-tech products in the real sector of the economy. While the percentage of R&D executed by Doctors of Science (Dr. Sci.) in the “real sector” more than doubled (from 155 to 339) between 2005 and 2016, the actual sector only comprised 0.65% to 1.21% of the entire population of employees in the same period (Table 1). This can be characterized as a complete absence of such.

Overall, examining the ratio of workers involved in R&D to the population of the Russian Federation (RF) from 1992 to 2021, as demonstrated in Table 2, showcases the percentage of human capital within the economy capable of increasing high-tech production, generating value-added, and advancing scientific knowledge; at least five periods of human capital crisis can be identified. These crises have led to a 57% decline in the entire scientific and technological potential over the past 30 years and established a long-term trend for the predicted sixth crisis.

Table 2

Distribution of the number of employees of organizations that carried out R&D, having a Dr. Sci. degree from 2005 to 2016 by sections

Year	1992	1995	1996	1998	2000	2008	2009	2014	2015	2021	2023	2033
Human capital crises	**The first structural crisis of the collapse of the USSR**		**2th**		**3th**		**4th**		**5th**		**Forecast of the 6th crisis**	
Number of employees who performed R&D	1 532 618	1 061 044	990 743	855 190	887 729	761 252	742 433	732 274	738 857	662 702	654 259	582 384
Population of Russia	148.51	148.46	148.29	147.80	146.89	142.75	142.74	143.67	146.27	146.17	146.42	148.91
Ratio of the number of employees performing scientific research to the population, %	1.03 %	0.71 %	0.67 %	0.58 %	0.60 %	0.53 %	0.52 %	0.51 %	0.51 %	0.45 %	0.45 %	0.39 %
Share of lost sci-tech personnel potential by 1992	**31%**		**44%**		**50%**		**52%**		**57%**		**62%**	

Source: Developed by the author based on Rosstat (2023b) and Global Finances (2023)

The first crisis can be described as "The Crisis of the Collapse of the USSR." It was marked by the introduction of the subsistence minimum and the minimum wage, which were established by the Presidential Executive Office (1992). This completely destroyed the social image, exceptional status, and economic attractiveness of the sci-tech fields among the country's population. Within just three years, from 1992 to 1995, this led to a loss of 31% of Russia's entire sci-tech potential while maintaining the population size (Table 2).

The second crisis can be described as the transition from state planning to market self-regulation in sci-tech development. This resulted in the destruction of individual sectors' strategic planning, decreased R&D orders, an ongoing decline in scientists' real wages, and disrupted interaction between research institutes and businesses. Over three years, from 1996 to 1998, it caused a further loss of 13% of Russia's sci-tech potential, bringing the cumulative indicator to 44% of the 1992 base year (Table 2).

The third crisis, known as "The crisis of transformational reforms and the disruption of a demographic succession of scientific generations," was caused by a lack of structured government policies, as identified by Dozortsev and Starokozheva (2021). This was compounded by the natural aging of scientific personnel who entered the field from 1949 to 1968 and the failure to attract young scientists from 1992 to 2004, as noted by Shepelev (2020). Over the course of eight years, from 2000–2008, this resulted in a further 6% decline in Russia's sci-tech potential, bringing the cumulative indicator to 50% of the 1992 base year (Table 2).

The fourth crisis, the "Investment crisis of the global financial-economic crisis of 2008–2009," reduced the investments of the world's largest economies for R&D as a percentage of

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GDP by more than 4% over the next five years (Kolomiets, 2023b); from 2008 to 2014, it led to a loss of another 2% of Russia's sci-tech potential, bringing the cumulative indicator to 52% of the 1992 base year (Table 2).

The fifth crisis, referred to as the "Crisis of International Hybrid Wars," aims to undermine Russia's global reputation as a reliable partner in all spheres of activity. This crisis has resulted in a surge in migratory labor from the tangible sector of the economy and a decrease in the number of scientists and developers in the "Entrepreneurial Sector," dropping by over 25% from 4281 to 3211 (Table 1) in 2015–2021. Furthermore, this crisis has caused an additional loss of 5% of Russia's sci-tech potential, contributing to an overall loss of 57% compared to the base year of 1992 (Table 2).

The sixth crisis, named "Foreseeable" (Table 2), is predicted based on trend indicators such as the number of employees involved in R&D and population size. The percentage of employees involved in R&D within the population structure is projected to decline to 0.39%; in the next ten years, Russia's sci-tech potential may decrease by an additional 5%–7%, resulting in a cumulative loss of 62% compared to the base year of 1992 (Table 2).

Discussion

Numerous scientific articles have highlighted insufficient government investments in the "knowledge economy" as the main reason for Russia's sci-tech potential crises, weak GDP growth, etc. To determine the applicability of this concept of economic development, we can compare the changes in the Knowledge Economy Index's dynamics (EBRD, 2019) and its influence on countries' GDP during the period of exponential growth of the world's leading countries. Data on changes in the knowledge economy index and its impact on the GDP growth of countries over 12 years during the period of exponential GDP growth of the leading countries (China and India) from 2000 to 2012 (Kolomiets, 2023e).

In this comparison, we can observe that despite significant increases in China and India's GDP, their Knowledge Economy Index (KEI) has remained low over the course of 12 years, averaging only 3–4 points. This suggests a lack of correlation between KEI and economic growth. Similarly, there is no evident correlation between R&D expenditures and GDP growth, as the allocation of funding and mechanisms used are more important. China's data shows that a significant portion of GDP growth stems from investing in technology transfer and attracting sci-tech talent rather than the traditional "knowledge economy" approach.

Based on data for China, we can calculate the normalized number of researchers and engineers required per $1 billion of a country's GDP. To sustain such growth momentum, no less than 190 R&D and engineering personnel would be necessary per $1 billion of GDP (Kolomiets, 2023d). Moreover, with technological advancement and transitioning to produce high-tech goods, the demand for R&D and engineering personnel continues to increase annually. By calculating growth every five years, we can derive the "planned index of R&D and engineering personnel growth" required for planning to ensure GDP growth in the real sector of the economy.

Conclusion

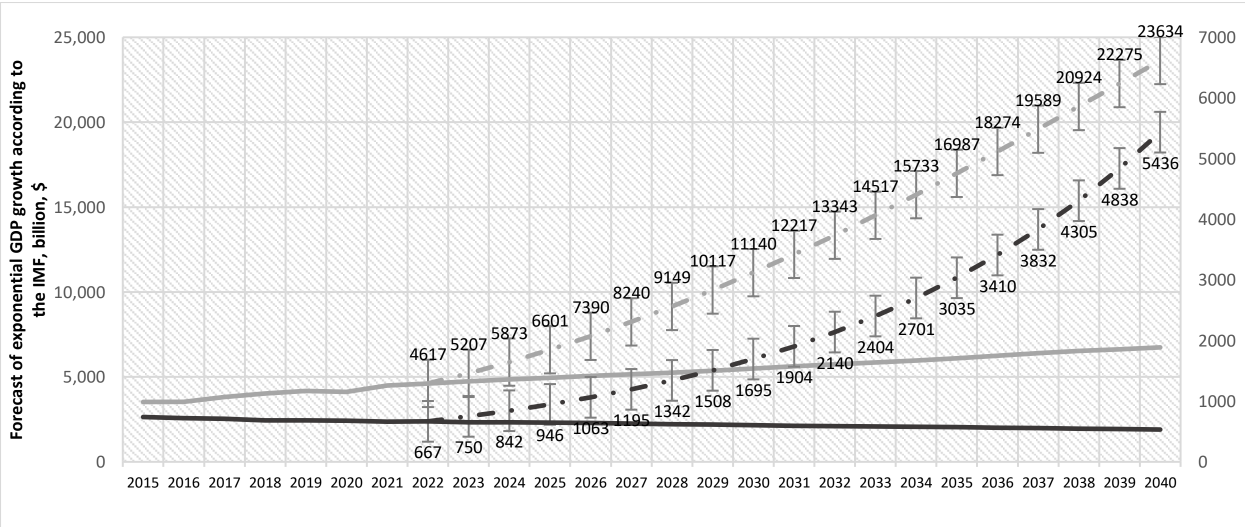
Thus, the above analysis of macroeconomic indicators clearly demonstrates that the “scientific and technical personnel potential,” which includes the engineering workforce employed in the entrepreneurial sector, plays a crucial role in shaping, developing, and supporting new technologies and ensures the exponential growth of the country’s GDP. Therefore, to ensure social-economic growth, innovative development, import substitution, and the transition of the Russian economy from stagnation to development, it is necessary to restore the system of state planning of scientific and technological progress, including the following:

a) Development of public-private programs for the scientific and technological development of the country, with annual updates and increased investments in the transfer and development of technologies.

b) Programs for state-private scientific and technological development in each industry and the economic sector should include plans for increasing the number of jobs in scientific, technological, and engineering fields as a proportion of the number of enterprises in the entrepreneurial sector and meet the requirements of the “General Plan for Attraction and Training of Scientific, Technological, and Engineering Personnel” in Russia (Kolomiets, 2023c). The plan envisages an increase in the number of scientific, technological, and engineering personnel from 667000 to 5436000 by 2040, corresponding to the planned exponential growth of GDP and the projected demand for high-tech production, considering the increasing complexity of technologies, as shown in Fig. 1.

Figure 1

Forecast of the need for R&D employees under the plan of exponential growth of Russia’s GDP by the years up to 2040



Source: Developed by the authors based on Rosstat (2023b) and NBSC (2023)

c) For each program, new tax regimes should be developed by sector of the economy without being tied to special economic zones or other geographic conditions in the territory of the Russian Federation. The tax regime should depend on the proportion of investments in increasing the personnel of scientific and technological composition of enterprises, including the engineering staff, the share of R&D, and the share of innovative products exceeding the benchmark of foreign technologies with full localization, investments in the transfer of technology in the total share of enterprise investments.

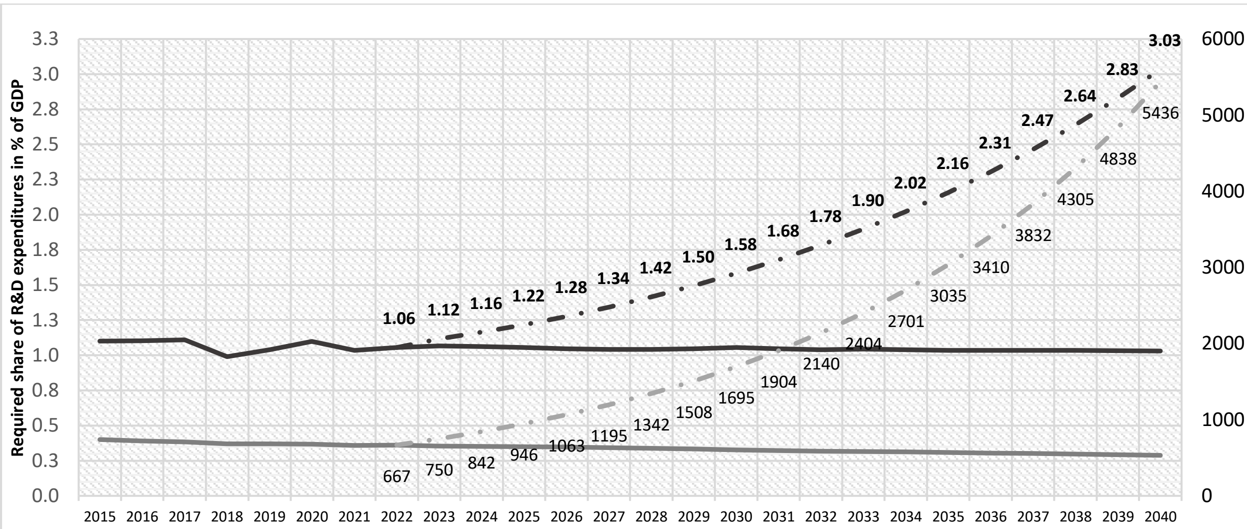
d) Sector-specific motivational mechanisms and personnel grading systems should be developed for R&D engaged in increasing the share of R&D, innovation, and localization of innovative products exceeding foreign technology benchmarks. These mechanisms should also aim to improve the social image, exclusive status, and economic attractiveness of this direction over any other accompanying service functions or administration.

e) Programs of tax breaks should be developed. These tax breaks should fully reimburse any expenses for scientific, research, experimental, design, patent, and legal support activities, including investments in contracts to transfer technologies.

f) Budgetary redistribution and increasing expenditures as a percentage of the planned exponential growth of Russia's GDP (Fig. 2), exceeding the level of R&D spending of leading countries in the world, should be considered.

Figure 2

Forecast of the demand for R&D personnel in high-tech manufacturing and increasing technological complexity, based on the plan for exponential GDP growth over the years until 2040



Source: Developed by the authors based on Rosstat (2023b), NBSC (2023), and IMF (2022)

g) Programs aimed at enhancing R&D in the entrepreneurial sector should be developed in partnership with research institutions and universities. This can be achieved by establishing "government-subsidized credit programs" for joint projects and programs that involve setting up joint research laboratories in entrepreneurial enterprises. These programs should offer interest rates that are two times lower than the market rate, and the paid interest on this subsidized credit should gradually be compensated up to "0" through the "tax deduction" programs. This compensation should be granted after confirmation of actual project implementation, completion of individual stages of R&D, and achieving significant scientific and production results that surpass the best industry standards.

h) The legislative body should introduce the concept of "inalienable copyright on intellectual property." This would mean that employers do not have superiority over patents, technologies, know-how, etc. The inventor, author, scientific-technical group, institution, etc., should have the predominant power in this right and cannot be separated, sold, etc. They should receive a fixed percentage (e.g., 3%) of the financial results obtained by individuals and legal entities, including the military industry, using the specified patent, invention, know-how, etc. This right can be used for commercial purposes, but only within the territory of the RF. To prevent the outflow of funds abroad, it is necessary to create "special lifelong savings accounts for inalienable copyright payments." They can only be used to invest a "share of funds" in investment scientific and technical projects in the RF or for the needs of the author of intellectual property.

References

[1] Ministry of Economic Development of the Russian Federation. (2022, September 28). *Forecast of the socio-economic development of the RF for 2023 and for the planned period of 2024 and 2025.* Moscow, Russia. Retrieved from https://www.economy.gov.ru/material/file/ea2fd3ce38f2e28d51c312acf2be0917/prognoz_socialno_ekonom_razvitiya_rf_2023-2025.pdf (Accessed 20 February 2023)

[2] Presidential Executive Office. (1992). *Executive Order "On the system of minimum consumer budgets of the population of the RF"* (March 2, 1992, No. 210). Moscow, Russia. Retrieved from http://www.kremlin.ru/acts/bank/984 (Accessed 20 February 2023)

[3] Aganbegyan, A. G. (2014). Social and economic development of Russia: An analysis and a forecast. *Studies on Russian Economic Development*, *25*, 319-328. DOI: 10.1134/S1075700714040029

[4] Bazanova, E. (2019, October 8). Why Russia has not moved from stagnation to development in 20 years. Russian economy 1999–2019. *Vedomosti and Expert RA*. Retrieved from https://www.vedomosti.ru/economics/articles/2019/10/08/813068-20-let-stagnatsii (Accessed 20 February 2023)

[5] Dozortsev, O. E., & Starokozheva, V. P. (2021). Remuneration of employees in the scientific sphere. *Russian Journal of Labor Economics*, *8*(8), 865-880. DOI: 10.18334/et.8.8.112917

[6] European Bank for Reconstruction and Development (EBRD). (2019, March 22). *EBRD Knowledge Economy Index.* Retrieved from https://www.ebrd.com/news/publications/brochures/ebrd-knowledge-economy-index.html (Accessed 20 February 2023)

[7] Federal State Statistics Service of the Russian Federation. (2023a). *Number of employees in organizations conducting scientific R&D with a doctoral degree as of 2016*. Moscow, Russia: Rosstat. Retrieved from https://showdata.gks.ru/report/277108/ (Accessed 20 February 2023)

[8] Federal State Statistics Service of the Russian Federation. (2023b). *Number of employees who performed R&D.* Moscow, Russia: Rosstat. Retrieved from https://showdata.gks.ru/report/273790/ (Accessed 20 February 2023)

[9] Fomichev, O., Gokhberg, L., Kuzminov, Y., Laykam, K., & Shadrin, A. (Eds.). (2015). *Indicators of innovation in the Russian Federation, 2015*. Moscow, Russia: HSE University. Retrieved from https://www.hse.ru/data/2016/02/08/1140135302/Innov_2015e_сайт.pdf (Accessed 20 February 2023)

[10] Global Finances. (2023). *Population of Russia by years, 1992–2023*. Retrieved from http://global-finances.ru/chislennost-naseleniya-rossii-po-godam/ (Accessed 20 February 2023)

[11] Import substitution in Russia. (2023, June 20). In *Wikipedia*. Retrieved from https://ru.wikipedia.org/wiki/Импортозамещение_в_России (Accessed 20 February 2023)

[12] International Monetary Fund (IMF). (2022). *Rating of countries by gross domestic product in 2022.* Retrieved from https://svspb.net/danmark/vvp-stran.php (Accessed 20 February 2023)

[13] Ivanter, V. V. (2017). Structural-investment component of the long-term economic strategy of Russia. *Obshchestvo i ekonomika* [Society and Economics], *8*, 5-32.

[14] Kolomiets, V. (2023a). *Gross domestic product of countries in 1980-2021(IMF; PPP, billion dollars).* figshare. Figure. https://doi.org/10.6084/m9.figshare.23548092.v2

[15] Kolomiets, V. (2023b). *Change in R&D Costs as a Percentage of GDP during the Investment Crisis from 2009 to 2013.* figshare. Dataset. https://doi.org/10.6084/m9.figshare.23546646.v2

[16] Kolomiets, V. (2023c). *Forecast of the need for R&D employees under the plan of exponential growth of Russia's GDP by the years up to 2040.* figshare. Figure. https://doi.org/10.6084/m9.figshare.23548014.v2

[17] Kolomiets, V. (2023d). *Analysis of correlation between the number of researchers, contract costs for technology transfer, patent activity, and GDP growth dynamics.* figshare. Dataset. https://doi.org/10.6084/m9.figshare.23547993

[18] Kolomiets, V. (2023e). *Comparison of changes in the knowledge-based economy index and its impact on the GDP growth of countries over 12 years during the exponential GDP growth period of leading countries (China, India) from 2000 to 2012.* figshare. Dataset. https://doi.org/10.6084/m9.figshare.23547933.v2

[19] National Bureau of Statistics of China (NBSC). (2023). *Chinese Statistical Yearbook, 2019: Chapter* '*Science and technology".* Beijing, China: Chinese Statistical Press. Retrieved from http://www.stats.gov.cn/sj/ndsj/2019/indexeh.htm (Accessed 20 February 2023)

[20] Shepelev, G. V. (2020). Dynamics of scientific personnel in the transition from the USSR to the Russian Federation. *Science Management: Theory and Practice*, *2*(4), 164-187. DOI: 10.19181/smtp.2020.2.4.7

[21] Sitnikov, E. V. (2020). Transition to the new economic policy of Russia: Response to threats, challenges and risks. *Innovations*, *6*(260), 32-41. DOI: https://doi.org/10.26310/2071-3010.2020.260.6.004