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Human capital quality and its impact on economic growth of Russian regions

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Abstract

Purpose: is to empirically substantiate the impact of human capital quality on the economic growth of the regions of Russia on the basis of theoretical and methodological generalization of its main aspects.

Methods: along with traditional methods, specific methods were used, such as content analysis, methods of expert assessments and comparative analysis, and the calculation and graphic technique of Xiang-Yeaple, which allowed to identify the state of human capital quality, as well as establish its optimal structure suitable for dynamic economic development.

Results: the cognitive and non-cognitive parameters of human potential are established as a realistic factor in the dynamics of gross regional product that determines the future pace of economic development. A comparative analysis of the labor demand and supply elasticity coefficients has revealed the degree of impact of its quality in ensuring the corresponding trends of economic growth. It was proven that significant investments in human capital and high levels of its development represent only a factor of ensuring economic growth and don't guarantee its achievement. Recommendations for ensuring the development of labor potential as determinant of economic development, the growth rates of which largely depends on the human capital quality.

Conclusions and Relevance: the Russian economy should focus on the formation and development of high-quality human capital through talent-fueled innovation by reforming the existing education system and assessing scientific potential in order to optimize the labor and branch structure suitable for high-quality economic growth. Human capital should be structured considering the parameters of its quality, the level of available labor potential, and the types of activities that require advanced knowledge for systemic economic growth.

Keywords: human potential, labor factor, cognitive and non-cognitive parameters, HCQ-index, human development index, regional disparity, innovation, economic growth

Conflict of Interest. The authors declare that there is no Conflict of Interest.

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Научная статья

Качество человеческого капитала и его влияние на экономический рост регионов России

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Аннотация

Цель статьи состоит в эмпирическом обосновании влияния качества человеческого капитала на экономический рост регионов России на основе теоретико-методического обобщения его основных аспектов.

Методы. Наряду с традиционными, в процессе работы использованы специфические методы исследования – контент-анализ, методы экспертных оценок, компаративного анализа и расчетно-графический прием Сяна-Йипла, которые позволили выявить состояние показателей качества человеческого капитала, а также установить его оптимальную структуру, подходящую для динамического экономического развития.

Результаты работы. Установлены параметры когнитивного и некогнитивного человеческого потенциала как реалистичного фактора динамики валового регионального продукта, определяющего будущие темпы экономического развития. Сравнительный анализ коэффициентов эластичности спроса и предложения рабочей силы позволил выявить степень влияния ее качества на обеспечение соответствующих тенденций экономического роста. Доказано, что значительные инвестиции в человеческий капитал и высокий уровень его развития представляют собой фактор, лишь содействующий экономическому росту, но не гарантирующий его достижения. Даны рекомендации по обеспечению формирования трудового потенциала как фактора развития экономики, темпы роста которой во многом зависит от качества человеческого капитала.

Выводы. Российская экономика должна быть ориентирована на формирование и развитие высококачественного человеческого капитала. Достижение этого возможно посредством кадровых инноваций, путем реформирования существующей системы образования и оценки научного потенциала с целью оптимизации трудовой и отраслевой структуры, необходимой для экономического развития. Человеческий капитал должен быть структурирован с учетом его качественных параметров, уровня имеющегося трудового потенциала и видов деятельности, требующих передовых знаний для системного экономического роста.

Ключевые слова: человеческий потенциал, трудовой фактор, когнитивный и некогнитивный человеческий капитал, HCQ-индекс, индекс человеческого развития, региональные различия, инновации, экономический рост

Конфликт интересов. Авторы заявляют об отсутствии конфликта интересов.

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Introduction

The size of the cross-border flow of production elements such as material capital, human capital, and technology has increased as a result of globalization. Global factor endowment, human capital structure, trade and investment structure, economic reforms, and productivity growth have all been impacted as a result. Russian economic development has shifted from a high-speed to a high-quality mode in recent years. This transformation necessitates a shift from a factor- and investment-scale-driven economy to an innovation-driven economy. Human talent drives an innovative economy. The new development mode requires Russia to allocate strategic and innovative resources for recruitment, development, upgrading economic growth, and promoting innovation.

Many domestic representatives of the scientific community state, "We should consider innovation as

the first driving force of development, talent as the first resource to support development, and innovation as a key position in the overall development of the country". Talent plays a vital role in scientific and technological innovation, and countries are creating competitive advantages based on talent [1]. Transforming and upgrading a country's industrial structure to ensure high-quality economic development requires high-quality human capital. For future growth and competitiveness, Russia must adopt policies aimed at transforming the "demographic dividend" into a "talent dividend".

The relationship between human capital and economic growth has attracted the attention of the economics research community. Due to the lack of comprehensive indicators to measure human capital, research in related fields is severely limited. In this article, we empirically study the impact of Russian human capital quality (HCQ) on the economic growth of the country and its regions. We rely on the general equilibrium model of Xiang and Yeaple [2] to classify human capital as cognitive or non-cognitive based on job characteristics. Human capital must be multidimensional; the non-cognitive aspect is very important. This classification helps calculate the cognitive and non-cognitive productivity of human capital using macro data at the regional level and microdata of individual workers in countries. In addition, we obtained the regional Human Capital Quality Index (HCQI).

The main points of this article are as follows.

First, despite its interest and importance, progress in human capital research has been hampered by the difficulty of developing indicators that comprehensively measure human capital [1]. Moreover, the existing literature treats human capital as a single entity, often measured by years of education. Ignoring non-cognitive abilities and considering only cognitive abilities developed through education fails to capture the connotations of human capital and may lead to biased and distorted estimates of the impact of human capital [3]. Contrary to the position of the existing current literature, we consider cognitive and non-cognitive human capital (CoHC and nCoHC) individually in different regions and new entities of the country, thereby enriching the paradigm and theoretical framework of human capital research.

Second, human capital can provide services as a content factor of trade, and factors of production such as capital and labor have higher mobility within the country than outside the country. Therefore, we calculate the HCQI of an open economy by considering both domestic and international trade flows. This process results in realistic measures of the quality of human capital in different regions and entities of Russia.

Third, we empirically analyze the impact of human capital quality on economic growth and its regions. The results show that differences in HCQI can help explain differences in economic growth across different regions and entities of Russia. We compare the results for different regions to provide region-specific policy recommendations.

This study examines the impact of the HCQ on economic growth in different regions of the country. The results have implications for public policy and governance. Our model and results can help in developing policies of central and regional institutions to create a human capital structure suitable for quality economic growth in Russia [2]. Regional disparities in economic development can also be addressed by improving the HCQ. Our study emphasizes the need to reform the country's education system. It provides recommendations for regional authorities to establish a system of scientific classification and talent assessment, which can contribute to the formation of a human and industrial structure suitable for high-quality growth [3].

To achieve our research objectives, we conducted a corresponding literature review, considered the characteristics of using the empirical general equilibrium model to assess the HCQ in Russia, evaluated its parameters, and identified the main socioeconomic consequences of the HCQ decline in Russia.

Literature Review

We established in previous research that the concept of "human capital" arose as a result of a greater understanding of people's roles and the activities that determine the dynamics and qualitative characteristics of economic growth. The interpretation of the basic concept, around which it is built, has undergone significant transformation during the evolution of this concept [3]. In solving the problem under consideration, C. Xiang and S. Yeaple made a special contribution by offering their research approaches [2].

T.W. Schultz defined human capital as knowledge, skills and health that are built and acquired through investment. Human resource quality is difficult to accurately quantify. Human capital, according to him, can be quantified by looking at activities that can help strengthen various human abilities [4].

[1] Mabiala G., Linskiy D.V., Maslich E.A., Bairakova I.V., Romaniuk E.V. The Socio-spatial stratagems of human capital development in the Southern Federal Districts of Russia. *MIR (Modernization. Innovation. Research)*. 2023; 14(2): 294–315. EDN: https://www.elibrary.ru/mpdoah. https://doi.org/10.18184/2079-4665.2023.14.2.294-315

[2] Ibid.

Several studies use the average duration of education as a proxy for measuring human capital. As human capital theories evolved, several researchers pointed out flaws in evaluating human capital solely by education level while ignoring other non-school-related HCQs. Education level alone can't accurately measure human capital. A variety of factors, such as economic branch structure, may influence the optimal type and level of human capital in different areas and countries [3, 4].

Compared to the traditional theory of human capital, the new approaches to its definition refute the premise of homogeneity among workers, while questioning the hypotheses of labor market equilibrium and full contract in traditional models of human capital. Numerous studies of labor market models have shown that the production skills of cognitive abilities (CoA) and the economic value of non-cognitive abilities (nCoA) should be distinguished in the connotation of human capital [5, 6]. CoA and nCoA have been shown to influence schooling, employment, work experience, occupational choice, and risk-taking behavior. Several papers emphasize the role of non-cognitive abilities in the labor market and consider their influence on some behavioral outcomes to be stronger than cognitive abilities [7, 8].

Recent theories of human capital study the mechanisms of the formation and cultivation of CoA and nCoA. They also examine the impact of different abilities on economic and social behavior and performance. Therefore, new theories of human capital are based on different "abilities", while traditional theories of human capital often emphasize education and health [5, 9].

Previously, those who studied this issue were unable to reach an agreement on how to assess cognitive abilities. Cognitive abilities are classified by psychologists into two types: fluid intelligence and crystallized intelligence. Fluid intelligence is concerned with solving new problems and can be measured by IQ. Crystal intelligence primarily reflects current knowledge and grows with education and age. Non-cognitive abilities, in their opinion, encompass psychological factors such as personality traits, which are difficult to quantify. While psychologists commonly use personality traits to assess cognitive abilities, they use non-cognitive skills or abilities as an umbrella term to express abilities not covered by cognitive abilities [8, 9].

The impact of CoA and nCoA on human capital accumulation and productivity is the focus of this research. We do not separate diverse parts of nCoA such as leadership, communication, and social skills, which are not reflected in tests and will not increase with time. The personal contributions of parents, as well as some social influence, play an important role in the development of a person's non-cognitive talents [8]. In comparison to classic human capital theory, innovations and methods challenge the premise of worker homogeneity. Bowles et al. questioned the classic human capital model hypotheses of labor market equilibrium and complete contract. They claimed that employees hold "disequilibrium rent" and "incentive-enhancing preferences". These traits contribute to understanding the role of non-cognitive abilities (nCoA) in gaining economic gains. According to the reconstruction of the labor market model, the connotations of human capital should stress CoA-producing skills and the economic value of nCoA [5].

Human capital is undeniably important for economic and social development. Comprehensive human capital metrics, however, are difficult to establish due to the complex and diverse factors affecting human capital and the difficulties in gathering relevant data [10].

Therefore, as in many scientific works on this topic, to assess the degree of quality and development of human capital, we will use such determinants and parameters as years of education, health levels, etc. Scientists suggested a metric based on total human capital development investment. However, such information is uncommon in Russia, with only a few studies employing the investing strategy [8]. Understanding and measuring human capital scientifically, as well as studying its impact on Russian economic development are of practical importance. This study employs a general equilibrium model for CoHC and nCoHC in Russia, using provincial macro-level and individual micro-level data, based on recent advances in human capital theory [9]. Using the model and data, we assessed the productivity of CoHC and nCoHC, as well as HCQI for some regions and districts of the Russian Federation.

Materials and methods

The methodological basis of our research was the use of a parametric apparatus for calculating and evaluating HCQ. The production model proposed by S. Xiang and S. Yeaple was reflected in the calculation of general equilibrium in the labor market, which allows us to establish various categories of human capital [3].

J.J. Heckman, T. Kautz [8] and G. Wang [5] investigated the terms for cognitive and non-cognitive productivities, combining them to define HCQI. The model identifies human capital supply using optimal labor choices and calculates demand based on enterprise production behavior, establishing equilibrium through clearing the global factor market. The execution of a parametric analysis of human capital quality necessitates the systematic application of the algorithm of all the formulas presented below (1–9).

Statistical data sources and parametric calculations. Our research consists of various Russian regions, based on statistical data and parametric models [4, 11–13].

• *CoHC and nCoHC productivity* Education investment primarily focus on exam performance. Education prioritizes cognitive abilities over developing non-cognitive qualities, unlike in developed countries. The average schooling period can indicate cognitive human capital (CoHC) creation in different regions of the country. It should be noted that CoHC is directly proportional to the number of years of education [11, 14]:

$$S^k = b\frac{L_C^{ks}}{L^k}, \quad S^k \neq 0, \qquad b > 0\,, \qquad (1)$$

Where: S^k is the average level of CoHC for a group of regions (k), L_C^{ks} is the total supply of CoHC; L^k is the total labor supply for the corresponding regions k.

Such scores do not accurately reflect the amount of CoHC in different parts of Russia. CoA develops with education, however, non-cognitive qualities such as personality traits are essentially unaffected by education length [12, 15].

The related method analyzes and compares HCQ trends across Russia, addresses the scarcity of micro-survey data, and examines the relationship between HCQ and regional economic growth (REG). Equation 2 permits to establish the dependence of education average term on the resources expended [2, 11, 14].

$$\frac{S^k}{S^o} = \left(\frac{\frac{Y^k}{L^k}}{\frac{Y^o}{L^o}}\right)^{\eta} \left(\frac{P_c^k}{P_c^o}\right)^{1-\frac{1}{\theta}} \left(\frac{h_c^k}{h_c^o}\right) \qquad (2)$$

Where: S^o specify a base region to which all other regions can be compared; $\frac{Y^o}{L^o}$ and $\frac{Y^k}{L^k}$ are respectively the per capita income level for a base and corresponding regions; η is the elasticity coefficient of human capital production; P_c^o and P_c^k are is share of the cognitive employment occupation for a base and given regions; θ is the labor supply elasticity; h_c^o and h_c^k is CoHC productivity, respectively for a base and corresponding regions.

The comparative advantage of CoHC and nCoHC productivity is expressed as follows [2, 10, 11]:

$$\frac{\frac{h_c^k}{h_n^k}}{\frac{h_c^o}{h_n^o}} = \left(\frac{\frac{P_c^k}{P_n^k}}{\frac{P_c^o}{P_n^o}}\right)^{\frac{\theta+\alpha-1}{\theta(\alpha-1)}} \left(\frac{1-x_c^k}{1-x_c^o}\right)^{\frac{1}{\alpha-1}}, \qquad (3)$$

Where: x_c^o and x_c^k are respectively the net export rate of the type $i \in (c,n)$ labor force in the base region and given regions k; α and θ are labor demand and supply elasticity coefficients.

Xiang and Yeaple established, $h_c^o = h_n^o = 1$ as a benchmark region for two types of human capital productivities. Different regions may have different labor supply and demand. The following conditions must be met for the factor market in k regions [2]:

$$\frac{L_n^{kD}}{L_c^{kD}} = \frac{L_n^{kS}}{L_c^{kS}}\left(\frac{1-x_n^k}{1-x_c^k}\right), \qquad (4)$$

Were: L_c^{kD} and L_n^{kD} are the total demand of CoHC and nCoHC; L_c^{kS} and L_n^{kS} are the total supply of CoHC and nCoHC respectively.

Migration flows and the costs related to this phenomenon of human movement have a substantial impact on the parameters of the human capital quality of the country and its regions. Therefore, finding solutions to balance the local labor market is one of the most crucial points. To balance the local input (factors) market, it is necessary to achieve the following conditions [12, 13]:

$$\sum_{k\in M_c} X_c^k \cdot L_c^{kS} + \sum_{k\in X_c} X_c^k \cdot L_c^{kS}(d^k) = 0\,, \qquad (5)$$

Where: M_c and X_c respectively, are regions that import and export cognitive labor; d^k is the migration costs for workers moving to another region.

We compute the factor content of trade flows in the same way used by *C.* Xiang and *S.* Yeaple [2], D. Ivanov [12], and X. Zhao [15]. The share of CoHC and nCoHC occupations (p_c^k and p_n^k) was determined using the regional intersectoral input-output, and the net export ratio of CoHC and nCoHC for a period from 2018 to 2022. With the given values α and $\varnothing$, the regional nCoHC productivity h_n^k is calculated [7, 14].

Human Capital Quality Index (HCQI). Per capita output differences can be categorized into HCQ and output total factor productivity (TFP), with cognitive and non-cognitive factors influencing HCQI [4, 9]:

$$\frac{\frac{Y^k}{L^k}}{\frac{Y^o}{L^o}} = \left(\frac{\varnothing^k}{\varnothing^o}\cdot H^k\right)^{\frac{1}{\alpha-1}}, \qquad (6)$$

Where; $\varnothing^o$ and $\varnothing^k$ are respectively the output TFP of a base and given regions k, which reflects the influence of the human capital factor on the level of total output; H^k is the HCQI for the given region k.

Human capital out-put elasticity coefficient (η). This coefficient (η) represents the proportion of education expenditure to aggregate human capital output. About ₽3.8 trillion will be allocated from the Russian budget for education in 2022–2024. More than ₽1.23 trillion will be allocated in 2022, more than

₽1.27 trillion in 2023 and ₽1.31 trillion in 2024 [3], with an estimated elasticity coefficient of 0.004677-0.004153.

Estimation of labor supply elasticity coefficient (θ). This elasticity coefficient (θ) measures the degree of dispersion of workers with cognitive and non-cognitive abilities. The expression for the calculation is:

$$ln\left(\frac{S^k}{(y^k)^\eta}\right) = \left(1 - \frac{1}{\theta}\right) lnp_c^k + lnh_c^k + C\,, \quad (7)$$

Where: S^k is the average years of schooling, y^k is output per worker in given regions k; η is human capital output elasticity coefficient; p_c^k is the share of cognitive occupation employment; h_c^k is the share of noncognitive occupation employment; C is a fixed value [13].

Estimation of labor demand elasticity coefficient. The labor demand elasticity coefficient reflects the substitution elasticity of workers with different CoA and nCoA. The indices for the net export rate of CoHC (x_c^k) and of nCoHC (x_n^k) are included in the expression for the labor demand elasticity coefficient:

$$ln\left(\frac{y^k}{S^k}\cdot\frac{1}{1-x_c^k}\right) = \left(\frac{\alpha}{\alpha-1}\right)\cdot ln\left[1 + \frac{p_n^k(1-x_n^k)}{p_c^k(1-x_c^k)}\right] + ln\emptyset^k + D\,, \quad (8)$$

Where: α is the labor demand elasticity coefficient; $\emptyset^k$ denotes region $k's$ output TFP; D is a constant parameter.

We assume that the labor force quantity and total factor productivity (TFP) in region k remain constant. The benchmark region can be used as the starting point.

$$\hat{Y}^k = \left[p_c^k\left(\hat{h}_c^k\right)^\theta + p_n^k\left(\hat{h}_n^k\right)^\theta\right]^{\frac{1}{\theta(1-\eta)}}, \quad (9)$$

Where: θ is the labor supply elasticity coefficient; $\hat{h}_c^k$ and $\hat{h}_n^k$ are CoHC and nCoHC production.

Equation (9) shows that both CoHC and nCoHC productivity h_c^k impact total output by influencing HCQI. Improvements in CoHC and nCoHC productivity (h_n^k) can boost regional total output. Better education encourages workers to choose cognitive occupations, resulting in a low proportion of non-cognitive occupations [16, 17]. By increasing the average number of years of schooling, workers' preferences for cognitive occupations would encourage people to accumulate CoHC.

A similar bias would result in a decrease in nCoHC. This inference is supported by Equations (8) and (9) [18]. It is possible to justify some indicators of human capital quality, the potential of the labor market, the regional differences in the supply and demand of labor, etc.

Results

Human capital is increasingly becoming a factor that enables the effective and sustainable operation of economic entities at the current stage of socioeconomic development. It is human capital that is the basis, and thanks to its presence, economic entities gain the opportunity to function with the fullest return.

Based on this, we can conclude that the organization of a well-functioning human capital is the key to solving a large set of strategic tasks for the economic growth of the country and its regions. It is necessary to accept the formulation of the concept of human capital as a set of qualitative competencies possessed by individuals living in the desired region and implement them in the economic sphere. This definition emphasizes the category of competence or the concept of the need to ensure human capital quality and improve its properties. According to this concept, labor force consumers are guided by a product that best corresponds to the highest level in technical, operational, and quality terms, thereby providing the greatest benefit to organizations [18, 19].

Our research was carried out in the context of the Russian Federation entities, which are listed in Article 65 of its modern Constitution: a total of 89 constituent regions and new entities of Russia, of which 24 are republics, 9 territories, 48 regions, 3 federal cities, 1 autonomous region, and 4 autonomous districts. Data on the population and relative numbers that make up the supply potential in the country's labor market are presented in Table 1.

The data given in Table 1 show that, on average, for 2018–2022, the human capital potential of Russia (PHC) is 57.0%, which is the working-age population of the country. In general, almost all Russian Federal Districts have PHC above the national average. The Chukotka Autonomous District (64.2%), the Republic of Ingushetia (62.4%), and the Magadan Region (61.8%) have the greatest PHC. It must be said that the success of the formation of human capital is determined by a

[3] About 3.8 trillion rubles will be allocated from the Russian budget for education in 2022–2024. TASS. https://tass.ru/ekonomika/12549109 (Accessed: 08.08.2023 r.) (In Russ.); Education in numbers. Brief statistical Bulletin. https://issek.hse.ru/mirror/pubs/share/749756927.pdf?ysclid=lm4jdce25i263660993 (Accessed: 10.08.2023) (In Russ.)

Table 1

The formation of human capital potential by regions of the Russian Federation,
on average for 2018–2022

Таблица 1

Формирование потенциального человеческого капитала по субъектам Российской федерации,
в среднем за 2018–2022 гг.

Subject of the Russian Federation	Population, thousand people	including		Potential human capital, %	Subject of the Russian Federation	Population, thousand people	including		Potential human capital, %
		younger than able-bodied	able-bodied				younger than able-bodied	able-bodied	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Russian Federation	**146447,4**	**27160,2**	**83440,4**	57,0	**Russian Federation**	**146447,4**	**27160,2**	**83440,4**	57,0
Central Federal District	**40240,3**	**6690,4**	**22901,9**	56,9					
Belgorod region	1514,5	252,8	854,2	56,4	Republic of North Ossetia – Alania	680,7	135,9	392,6	57,7
Bryansk region	1152,5	196,9	646,7	56,1	Chechen Republic	1533,2	495,9	879,1	57,3
Vladimir region	1325,5	215,1	736,1	55,5	Stavropol Territory	2891,2	530,7	1688,1	58,4
Voronezh region	2285,3	366,3	1289,2	56,4	**Volga Federal District**	**28683,2**	**5281,6**	**16029,8**	55,9
Ivanovo region	914,7	147,5	509,0	55,6	Republic of Bashkortostan	4077,6	810,6	2296,8	56,3
Kaluga region	1070,9	179,9	610,7	57,0	Republic of Mari El	672,3	131,3	370,2	55,1
Kostroma region	571,9	106,0	301,9	52,8	Republic of Mordovia	771,4	112,2	438,1	56,8
Kursk region	1067,0	181,7	588,9	55,2	Republic of Tatarstan	4001,6	775,5	2259,5	56,5
Lipetsk region	1126,3	190,9	631,2	56,0	Udmurt Republic	1442,2	293,7	796,3	55,2
Moscow region	8591,7	1589,2	5045,7	58,7	Chuvash Republic	1173,2	228,9	649,7	55,4
Orel region	700,3	114,4	388,2	55,4	Perm region	2508,4	507,9	1393,8	55,6
Ryazan region	1088,9	172,1	603,0	55,4	Kirov region	1138,1	195,7	605,9	53,2
Smolensk region	873,0	137,9	489,7	56,1	Nizhny Novgorod region	3081,8	537,2	1713,9	55,6
Tambov region	966,3	137,0	538,6	55,7	Orenburg region	1841,4	356,8	1021,5	55,5
Tver region	1211,2	201,2	666,6	55,0	Penza region	1246,6	196,5	691,7	55,5
Tula region	1481,5	216,5	829,2	56,0	Samara region	3142,7	547,2	1773,8	56,4
Yaroslavl region	1194,6	211,4	660,3	55,3	Saratov region	2404,9	388,0	1371,6	57,0
Moscow	13104,2	2073,6	7512,7	57,3	Ulyanovsk region	1181,0	200,1	647,0	54,8
North-Western Federal District	**13867,3**	**2263,0**	**8059,7**	58,1	**Ural Federal District**	**12259,1**	**2513,4**	**6937,9**	56,6
Republic of Karelia	527,9	90,7	289,5	54,8	Kurgan region	761,6	150,9	390,4	51,3
Komi Republic	726,5	136,3	417,5	57,5	Sverdlovsk region	4239,1	837,3	2368,6	55,9
Arkhangelsk region	1005,7	182,0	556,1	55,3	Tyumen region	3851,3	858,9	2275,5	59,1
Nenets Autonomous district	41,4	9,3	24,3	58,7	Khanty-Mansiysk auth. district – Yugra	1730,4	390,8	1053,1	60,9
Arkhangelsk region without autonomy	964,3	172,7	531,8	55,1	Yamalo-Nenets auth. district	512,4	118,9	326,7	63,8
Vologda region	1128,7	216,8	621,7	55,1	Tyumen region without autonomous regions	1608,5	349,2	895,7	55,7
Kaliningrad region	1032,3	183,1	600,2	58,1	Chelyabinsk region	3407,1	666,3	1903,4	55,9
Leningrad region	2023,8	284,7	1222,4	60,4	**Siberian Federal District**	**16645,8**	**3368,4**	**9371,2**	56,3
Murmansk region	658,7	125,7	391,6	59,5	Republic of Altay	210,8	57,2	115,9	55,0

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End of the table 1

Окончание таблицы 1

Subject of the Russian Federation	Population, thousand people	including		Potential human capital, %	Subject of the Russian Federation	Population, thousand people	including		Potential human capital, %
		younger than able-bodied	able-bodied				younger than able-bodied	able-bodied	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Novgorod region	575,9	102,0	314,0	54,5	Republic of Tyva	337,3	113,2	188,2	55,8
Pskov region	587,8	96,6	322,5	54,9	Republic of Khakassia	530,2	115,5	294,6	55,6
Saint Petersburg	5600,0	845,1	3324,2	59,4	Altai Territory	2130,9	417,9	1162,1	54,5
Southern Federal District	**16642,1**	**3023,6**	**9463,5**	56,9	Krasnoyarskiy kray	2845,5	568,1	1642,0	57,7
Republic of Adygea	498,0	98,8	283,8	57,0	Irkutsk region	2344,4	513,7	1313,1	56,0
Republic of Kalmykia	264,5	57,2	148,4	56,1	Kemerovo region – Kuzbass	2568,2	486,7	1447,2	56,4
Republic of Crimea	1916,8	358,6	1061,1	55,4	Novosibirsk region	2794,3	537,1	1585,3	56,7
Krasnodarskiy kray	5819,3	1107,3	3280,1	56,4	Omsk region	1832,1	360,8	1011,5	55,2
Astrakhan region	950,6	201,8	535,3	56,3	Tomsk region	1052,1	198,2	611,3	58,1
Volgograd region	2470,1	402,2	1430,8	57,9	**Far Eastern Federal District**	**7903,9**	**1607,2**	**4635,2**	58,6
Rostov region	4164,5	703,5	2389,7	57,4	Republic of Buryatia	974,6	232,6	551,5	56,6
Sevastopol	558,3	94,2	334,3	59,9	Republic of Sakha (Yakutia)	997,6	238,9	595,6	59,7
Zaporozhye region	x	x	x	x	Trans - Baikal Territory	992,4	217,5	580,7	58,5
Donetsk People's Republic	x	x	x	x	Kamchatka region	288,7	56,3	175,0	60,6
Luhansk People's Republic	x	x	x	x	Primorsky Kray	1820,1	320,0	1067,7	58,7
Kherson region	x	x	x	x	Khabarovsk Territory	1284,1	242,1	754,6	58,8
North Caucasus Federal District	**10205,7**	**2412,6**	**6041,2**	59,2	Amur region	756,2	152,0	442,0	58,5
Republic of Dagestan	3209,8	808,2	1952,1	60,8	Magadan region	134,3	24,7	83,0	61,8
Republic of Ingushetia	519,1	144,6	323,9	62,4	Sakhalin Region	460,6	82,6	269,7	58,6
Kabardino-Balkarian Republic	903,3	198,8	532,3	58,9	Jewish Autonomous region	147,5	29,9	84,7	57,4
Karachay-Cherkess Republic	468,4	98,5	273,1	58,3	Chukotka Autonomous district	47,8	10,6	30,7	64,2

Compiled by the authors based on materials: Population of Russian Federation by sex and age. Federal State Statistics Service. URL: https://rosstat.gov.ru/compendium/document/13284 (accessed: 20.08.2023) (In Russ.)

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large set of factors affecting its quality, systematizing the parameters of supply and demand in the labor market. Therefore, an interesting point is to analyze the state of the labor market by comparatively assessing the number of vacancies and resumes, as well as calculating the hh-index, which reflects the number of resumes compared to the number of vacancies on the market in the selected professional field [18]. The analysis base was chosen based on the availability and access to statistical information (Table 2).

Table 2 shows that the final data set contains 62435 observations of a vacancy shortage in the country as a whole and in nearly all of its regions. There were 404124 vacancies (demand for labor) and 556255 applicants, indicating that the supply of labor (number of applicants) exceeded the number of vacancies in some instances. According to this analysis, the labor supply per applicant exceeds the demand for jobs by coefficients of 1.376 and 1.268, respectively, when assessing the weight of labor supply (applicants) over the number of vacancies and based on the number of applications per vacancy.

There is an absolute surplus of resumes in Moscow – 103,911, but there are 1.95 resumes for every vacancy. The largest number of identified labor shortages was noted in the major cities of the country: Krasnodarskiy kray (-19398 people, or 1.826 resumes per vacancy), Nizhny Novgorod region (-7183 people, or 0.676 resumes per vacancy), Ryazan region (-6671 people, or 0.303 resumes per vacancy), Kirov region (-5598 people, or 0.351 resumes per vacancy), Samara region (-4980 people, or 1.370 resumes per vacancy), Rostov region (-4890 people, or 1.386 resumes per vacancy), etc. Moscow region (-3753 people, or 0.925 resumes per vacancy), Leningrad region (-2319 people, or 0.691 resumes per vacancy). As for the parameters of the vacancy shortage, the same trend is observed in all regions of the country. In almost half of the Russian regions, there is a shortage of personnel.

Based on the hh-index by regions of the country, it is possible to establish the leading regions both in terms of the number of resumes and the number of vacancies in terms of surplus or shortage of personnel. According to Table 2, of the regions considered, only one of them, the Chechen Republic, has a high level of competition among job seekers for jobs ($8.0 \leq hh \leq 11.9$); 4 regions, the Kaliningrad Region, Moscow city, the Republic of North Ossetia-Alania, and St. Petersburg, have a moderate level of competition for jobs, a healthy ratio between employers and applicants ($4.0 \leq hh \leq 7.9$). The rest of the studied regions have a shortage of applicants ($2.0 \leq hh \leq 3.9$).

We must agree that the excess of the number of resumes over the number of vacancies presented in Table 1, both in the country as a whole as well as in its regions, may be the result of subjective factors in the behavior of job seekers and does not reflect the actual state of the labor market. The indicated parameters of deficit and/or surplus do not show the number of unemployed labor forces, which exceeds the number of subjects of the Russian Federation employed in the economy [20, 21].

Using the test results on CoA and schooling average years, we estimate the labor supply elasticity coefficient in Russia. The relevant data are taken from the data of our previous studies, which present the results of the analysis of general trends in the age composition of the population and its active part (from 16 to 65 years old)[4] [16]. The database contains pertinent information such as the regions in which the investigated individuals live, education levels, cognitive test scores, and occupation codes. The Russian Family Panel Studies 2018–2022 (RFPS-2018–2022) data was cleaned by removing data points with missing, unknown, or ineffective memory or sequence test scores. The total number of observations in the final data set was 404124 [13]. Gruzina confirmed that Barro and Lee's method, which involves a weighted average of the education level and population proportion of employees in different regions, could also be used to calculate the index. The index S = 1.5 (the illiterate and semi-illiterate population share) +7.5 (the primary education population share) + 10.5 (the junior high school education population share) + 13.5 (the senior high school education population share) + 17 (the population share of those receiving tertiary education or above) and 50.0 (other factor parameters) [16].

The method for calculating the employment shares of cognitive and non-cognitive occupations is now described. Leadership ability can be used to categorize occupations as cognitive or non-cognitive. Other research takes a more nuanced approach, considering dimensions such as leadership, communication, and social skills [11, 16].

We distinguish between cognitive and non-cognitive occupations using a variety of parameters. Relevant information, such as regions where individual interviewees were located and current working status occupation codes, was extracted from the RFPS-2018-2022 database. Individuals with unemployed status, withdrawal from the labor market, inability to judge, and inapplicability are excluded [2, 22].

The least squares regression results for the Russian labor supply elasticity coefficient are shown in Table 3. A

[4] Mabiala G., Linskiy D.V., Maslich E.A., Bairakova I.V., Romaniuk E.V. The Socio-spatial stratagems of human capital development in the Southern Federal Districts of Russia. *MIR (Modernization. Innovation. Research)*. 2023; 14(2): 294–315. EDN: https://www.elibrary.ru/mpdoah. https://doi.org/10.18184/2079-4665.2023.14.2.294-315

Table 2

Supply-demand parameters and hh-indices in the Russian labor market, on average for 2018–2022

Таблица 2

Параметры спроса-предложения и hh-индексы на рынке труда России, в среднем за 2018–2022 гг.

Regions	Number of vacancies	Number of resumes	Category: surplus (+) or shortage of applicants (-)				hh-index	hh-index value
			Scope	Number of vacancies per 1 resume	Number of resumes per 1 vacancy	coverage ratio		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Arkhangelsk region	3197	2158	-1039	1.481	0.675	0.456	3.1	Shortage of applicants
Astrakhan region	1892	3067	-1175	0.617	1.621	2.628	3.6	Shortage of applicants
Chechen Republic	210	466	-256	0.451	2.219	4.924	11.1	High level of competition among applicants for jobs, employer market
Chukotka Autonomous region	96	234	-138	0.410	2.438	5.941	1.4	Acute shortage of applicants
Kaliningrad Region	3101	5100	-1999	0.608	1.645	2.705	4.2	Moderate level of competition for jobs, healthy ratio between employers and applicants
Kirov region	8621	3023	-5598	2.852	0.351	0.123	2.6	Shortage of applicants
Krasnodarskiy kray	23485	42883	-19398	0.548	1.826	3.334	2.8	Shortage of applicants
Kurgan region	1774	1024	-750	1.732	0.577	0.333	2.4	Shortage of applicants
Leningrad Region	7497	5178	-2319	1.448	0.691	0.477	2.2	Shortage of applicants
Moscow	109864	213775	103911	0.514	1.946	3.786	4.7	Moderate level of competition for jobs, healthy ratio between employers and applicants
Moscow region	50066	46313	-3753	1.081	0.925	0.856	3.0	Shortage of applicants
Nenets Autonomous District	63	373	-310	0.169	5.921	35.054	3.1	Shortage of applicants
Nizhny Novgorod region	22145	14962	-7183	1.480	0.676	0.456	2.8	Shortage of applicants
Novosibirsk region	13315	15223	-1908	0.875	1.143	1.307	3.1	Shortage of applicants
Republic of Adygea	936	644	-292	1.453	0.688	0.473	2.8	Shortage of applicants
Republic of Bashkortostan	13040	14430	-1390	0.904	1.107	1.225	3.5	Shortage of applicants
Republic of Mari El	1945	1289	-656	1.509	0.663	0.439	2.7	Shortage of applicants
Republic of North Ossetia-Alania	435	795	-360	0.547	1.828	3.340	5.2	Moderate level of competition for jobs, healthy ratio between employers and applicants
Republic of Tatarstan	18549	20621	-2072	0.900	1.112	1.236	3.1	Shortage of applicants
Rostov region	12682	17572	-4890	0.722	1.386	1.920	2.9	Shortage of applicants
Ryazan region	9573	2902	-6671	3.299	0.303	0.092	2.2	Shortage of applicants
Saint-Petersburg	44678	83082	38404	0.538	1.860	3.458	4.1	Moderate level of competition for jobs, healthy ratio between employers and applicants
Sakhalin Region	783	1271	-488	0.616	1.623	2.635	3.2	Shortage of applicants
Samara region	13461	18441	-4980	0.730	1.370	1.877	3.6	Shortage of applicants
Sverdlovsky region	16890	15681	-1209	1.077	0.928	0.862	2.5	Shortage of applicants
Tver region	5435	3736	-1699	1.455	0.687	0.473	2.4	Shortage of applicants
Tyumen region	6824	11071	-4247	0.616	1.622	2.632	3.8	Shortage of applicants

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End of the table 2

Окончание таблицы 2

Regions	Number of vacancies	Number of resumes	Category: surplus (+) or shortage of applicants (-)				hh-index	hh-index value
			Scope	Number of vacancies per 1 resume	Number of resumes per 1 vacancy	coverage ratio		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Udmurt Republic	6043	4008	-2035	1.508	0.663	0.440	3.0	Shortage of applicants
Vladimir region	5689	3861	-1828	1.473	0.679	0.461	2.1	Shortage of applicants
Yamalo-Nenets Autonomous District	1835	3072	-1237	0.597	1.674	2.803	2.9	Shortage of applicants
Total	404124	556255	62435	32.209	40.845	86.745	x	
			1.376			1.268	x	

Note: Demand – Number of vacancies, Supply – Number of and resumes.

Примечание: Спрос – количество вакансий, предложение – количество резюме.

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measure of cognitive capital is regressed on the average level of cognitive employment share in Equation 7. We employ R. Barro and J.-W. Lee's numerous measures of cognitive capital in this manner [23].

The significance of the calculations is presented in Table 3. Column (6) has the best goodness of fit, with $R^2 \approx 0.673$ and an estimated labor supply elasticity coefficient of 0.538. Using $(1 - 1/\theta) \approx 0.538$, the labor supply elasticity coefficient in Russia is $\theta \approx 2.1645$. Our estimate of θ is consistent with previous research.

Hsieh et al. (2013) proposed that innate abilities follow the Frechet distribution. They used a different method to show that $\theta = 2$ and concluded that the real value is $(1.5 \le \theta \le 2.5)$. Hendricks et al. [17] estimated θ in the $(1.78 \le \theta \le 2.62)$ and $(1.48 \le \theta \le 2.5)$ ranges, respectively.

Xiang and Yeaple [2] used data from high-income developed countries and estimated $\theta = 1.578$, concluding that θ was between 1.746 and 3.014. Our estimates in Table 3 for $1.568 \le \theta \le 2.886$. Therefore, we estimate that for regions in Russia, the elasticity coefficient of labor supply is equal to 2. Multiple estimation methods and validity from the literature strengthen our estimate of θ [2]. Based on formula 8, we estimated the coefficient of labor demand elasticity (Table 4).

As a result, the labor demand elasticity coefficient should be calculated using enterprise-related data. To calculate θ, we use employee structure data from listed companies from 2018 to 2022 from the statistical database. S^k was expressed using the average years of schooling obtained by the Barro-Lee calculation method [23].

Table 4 reports the least squares regression results for the Russian labor demand elasticity coefficient settings and trade or migration conditions across regions. The regression model applied relative data from the studied regions of Russia for the period from 2018 to 2022. The findings show that the labor demand elasticity is 1.57 and 1.65 under closed and open economic conditions, respectively. They calculated $\alpha = 1.78$ using the CES total production function, such as wages and employment, in many countries [10]. The regression coefficient calculated by many authors is around $\alpha = 1.68$ (with the cross-sectional data from G7 high-income countries) [2, 9].

Regional HCQ and per capita output. Regional differences exist in how education policy is oriented. The orientation of education policy results in differences in CoHC and nCoHC production. A high employment proportion in non-cognitive occupations may indicate comparative advantages in the formation of nCoHC, resulting in high nCoHC productivity. HCQI is calculated using Equations (1) and (2). According

Table 3

Estimated labor supply elasticity coefficient in Russia, on average for 2018–2022

Таблица 3

Расчетный коэффициент эластичности предложения рабочей силы в России, в среднем за 2018–2022 гг.

Parameters	Cognitive ability test score	Memory test score	Sequence test score	Average years of schooling, RFPS-2018–2022	Average years of schooling: Barro & Lee
(1)	(2)	(3)	(4)	(5)	(6)
lnp_c^k	0.347	0.425	0.346	0.666	0.538
Constant	6.460	1.605	6.450	2.364	2.663
N	30	30	30	30	30
R^2	0.546	0.496	0.546	0.626	0.673
θ *estimate*	1.578	1.774	1.576	2.886	2.165

Compiled by the authors based on formula (7)

Составлено авторами на основе формулы (7)

Table 4

Estimated labor demand elasticity in Russia, on average for 2018–2022

Таблица 4

Расчетная эластичность спроса на рабочую силу в России, в среднем за 2018–2022 гг.

Parameters	Cognitive ability test score	Memory test score
(1)	(2)	(3)
$ln\left(\frac{y^k}{S^k}\cdot\frac{1}{1-x_c^k}\right)$	2.681378542	x
$ln\left[1+\frac{p_n^k(1-x_n^k)}{p_c^k(1-x_c^k)}\right]$	x	2.90606215
Constant	8.256202462	8,299414891
N	372	372
R^2	0.124064882	109.3453195

Compiled by the authors based on formula (8)

Составлено авторами на основе формулы (8)

to the HCQI expressions, per capita output consists of HCQ and output TFP. The human capital output elasticity coefficient impacts how HCQI and output TFP contribute to per capita output [8, 9]. We calculate the impact of provincial HCQ and output TFP on Russian per capita output using relative data from all studied regions from 2018 to 2022 (Table 5–7).

We report the relevant parameters for Russia. The table's first column shows the average GDP per capita of various regions from 2018 to 2022. The GDP of 18 regions of the Central Federal District, 10 regions of the North-western District, 8 regions of the Southern Federal District, 6 regions of the North Caucasus Federal District, 14 regions of the Volga Federal District, 4 regions of the Urals Federal District, 8 regions of the Siberian Federal District, and 9 regions and territories of the Far East Federal District is ₽823527.433, ₽777399.917, ₽394682.200, ₽228252.900, ₽459497.733, ₽1018359.083, ₽513127.183, and ₽695661.813 respectively.

Tyumen's regional per capita GDP is higher than other Russian regions; it is higher than Moscow's and St. Petersburg's GDP (Table 5–7).

The relative per capita output index in Russia reveals a significant income disparity between regions. Is the income disparity in Russia explained by the HCQ and output TFP. Columns (4) and (6) show the contribution rates of HCQ and output TFP, respectively. We elaborate on the values of Belgorod Oblast Province. Belgorod Oblast Province has a lower per capita output than Tyumen. This disparity is caused by two factors. First, Belgorod Oblast Province's overall HCQ (Column 4) is only 69.6% that of Tyumen Oblast. Second, Belgorod Oblast Province's TFP is 40.6% of Tyumen Oblast's per capita output. The two effects combine to produce the Belgorod region's output per capita of 0.283= (0.696×0.406), which is 28.3% of the Tyumen region's level.

Table 5

Human capital Quality and the total output in the Central, North-Western and Southern Federal districts of Russia, in 2018–2022

Таблица 5

Качество человеческого капитала и совокупный выпуск в Центральном, Северо-Западном и Южном Федеральном округах России в 2018–2022 гг.

Districts / regions	The average value of GDP per capita	Output per capita	Average HCQI	The contribution rate of HCQI	Average of relative output TFP	The contribution rate of output TFP
(1)	(2)	(3)	(4)	(5)	(6)	(7)
GDP by entities of the Russian Federation. Total	**630975.467**	**0.284**	**0.735**	**0.698**	**0.424**	**0.407**
Central Federal District	**823527.433**	**0.371**	**0.959**	**0.911**	**0.553**	**0.531**
Belgorod region	628998.500	0.283	0.733	0.696	0.423	0.406
Bryansk region	320819.700	0.144	0.374	0.355	0.216	0.207
Voronezh region	428839.933	0.193	0.500	0.474	0.288	0.276
Ivanovo region	245326.183	0.110	0.286	0.271	0.165	0.158
Kaluga region	520794.517	0.234	0.607	0.576	0.350	0.336
Kostroma region	311495.400	0.140	0.363	0.344	0.209	0.201
Kursk region	442791.717	0.199	0.516	0.490	0.297	0.285
Lipetsk region	535140.333	0.241	0.623	0.592	0.359	0.345
Moscow region	670870.700	0.302	0.781	0.742	0.451	0.433
Orel region	360014.000	0.162	0.419	0.398	0.242	0.232
Tula region	460831.650	0.207	0.537	0.510	0.310	0.297
Moscow	1524669.767	0.686	1.776	1.686	1.024	0.983
North-Western Federal District	**777399.917**	0.350	**0.906**	**0.860**	**0.522**	**0.501**
Republic of Karelia	516166.100	0.232	0.601	0.571	0.347	0.333
Komi Republic	818558.283	0.369	0.954	0.905	0.550	0.528
Arkhangelsk region	738305.300	0.332	0.860	0.816	0.496	0.476
Vologda region	563450.367	0.254	0.656	0.623	0.379	0.363
Kaliningrad region	514646.683	0.232	0.599	0.569	0.346	0.332
Leningrad region	635058.383	0.286	0.740	0.702	0.427	0.409
St. Petersburg	1030494.850	0.464	1.200	1.140	0.692	0.664

End of the table 5

Окончание таблицы 5

Districts / regions	The average value of GDP per capita	Output per capita	Average HCQI	The contribution rate of HCQI	Average of relative output TFP	The contribution rate of output TFP
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Southern Federal District	**394682.200**	0.178	**0.460**	**0.436**	**0.265**	**0.254**
Republic of Adygea	281779.850	0.127	0.328	0.312	0.189	0.182
Republic of Kalmykia	316776.650	0.143	0.369	0.350	0.213	0.204
Republic of Crimea	241425.867	0.109	0.281	0.267	0.162	0.156
Krasnodarsky kray	462156.417	0.208	0.538	0.511	0.310	0.298
Astrakhan region	525018.067	0.236	0.612	0.581	0.353	0.338
Volgograd region	372754.667	0.168	0.434	0.412	0.250	0.240
Rostov region	386054.317	0.174	0.450	0.427	0.259	0.249
Sevastopol	275987.700	0.124	0.321	0.305	0.185	0.178
North Caucasus Federal District	**228252.900**	0.103	0.266	**0.252**	0.153	**0.147**
Republic of Dagestan	226656.700	0.102	0.264	0.251	0.152	0.146
Kabardino-Balkarian Republic	196233.433	0.088	0.229	0.217	0.132	0.127
Karachay-Cherkess Republic	194345.317	0.087	0.226	0.215	0.131	0.125
Republic of North Ossetia-Alania	243043.650	0.109	0.283	0.269	0.163	0.157
Chechen Republic	160240.850	0.072	0.187	0.177	0.108	0.103
Stavropolsky kray	293914.350	0.132	0.342	0.325	0.197	0.189

Compiled by the authors based on materials: National Accounts of Russia. Bulletins 2018–2022. Federal State Statistics Service. URL: https://rosstat.gov.ru/folder/210/document/13221 (accessed: 20.08.2023) (In Russ.)

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Table 6

Human capital Quality and the total output indicators in the North Caucasus, Volga and Ural Federal Districts of Russia, in 2018–2022

Таблица 6

Качество человеческого капитала и показатели совокупного выпуска в Северокавказском, Приволжском и Уральском Федеральном округах России в 2018–2022 гг.

Districts / regions	The average value of GDP per capita	Output per capita	Average HCQI	The contribution rate of HCQI	Average of relative output TFP	The contribution rate of output TFP
(1)	(2)	(3)	(4)	(5)	(6)	(7)
North Caucasus Federal District	**228252.900**	0.103	0.266	**0.252**	0.153	**0.147**
Republic of Dagestan	226656.700	0.102	0.264	0.251	0.152	0.146
Kabardino-Balkarian Republic	196233.433	0.088	0.229	0.217	0.132	0.127
Karachay-Cherkess Republic	194345.317	0.087	0.226	0.215	0.131	0.125
Republic of North Ossetia-Alania	243043.650	0.109	0.283	0.269	0.163	0.157
Chechen Republic	160240.850	0.072	0.187	0.177	0.108	0.103
Stavropolsky kray	293914.350	0.132	0.342	0.325	0.197	0.189
Volga Federal District	**459497.733**	0.207	**0.535**	**0.508**	**0.309**	**0.296**
Republic of Bashkortostan	418300.350	0.188	0.487	0.463	0.281	0.270
Republic of Mari El	285626.650	0.129	0.333	0.316	0.192	0.184
Republic of Mordovia	321924.817	0.145	0.375	0.356	0.216	0.208
Republic of Tatarstan	678204.400	0.305	0.790	0.750	0.456	0.437
Udmurt Republic	453354.050	0.204	0.528	0.501	0.305	0.292
Chuvash Republic	269781.683	0.121	0.314	0.298	0.181	0.174
Perm Territory	540137.667	0.243	0.629	0.597	0.363	0.348
Kirov region	295355.083	0.133	0.344	0.327	0.198	0.190
Nizhny Novgorod region	481895.233	0.217	0.561	0.533	0.324	0.311
Orenburg region	534756.717	0.241	0.623	0.591	0.359	0.345
Penza region	332036.517	0.149	0.387	0.367	0.223	0.214
Samara region	518073.300	0.233	0.603	0.573	0.348	0.334
Saratov region	334077.133	0.150	0.389	0.369	0.224	0.215
Ulyanovsk region	336382.100	0.151	0.392	0.372	0.226	0.217
Urals Federal District	**1018359.083**	0.458	**1.186**	**1.126**	**0.684**	**0.657**

End of the table 6

Окончание таблицы 6

Districts / regions	The average value of GDP per capita	Output per capita	Average HCQI	The contribution rate of HCQI	Average of relative output TFP	The contribution rate of output TFP
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Kurgan region	274467.417	0.124	0.320	0.304	0.184	0.177
Sverdlovsk region	575471.717	0.259	0.670	0.636	0.387	0.371
Tyumen region	**2221130.917**	**1.000**	**2.587**	**2.456**	**1.492**	**1.432**
Chelyabinsk region	454569.133	0.205	0.530	0.503	0.305	0.293

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Table 7

Human capital Quality and the total output indicators in the Siberian and Far Eastern federal districts of Russia, in 2018–2022

Таблица 7

Качество человеческого капитала и показатели совокупного выпуска в Сибирском и Дальневосточном федеральном округах России, 2018–2022 гг.

Districts / regions	The average value of GDP per capita	Output per capita	Average HCQI	The contribution rate of HCQI	Average of relative output TFP	The contribution rate of output TFP
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Siberian Federal District	**513127.183**	**0.231**	**0.598**	**0.567**	**0.345**	**0.331**
Altai Republic	259481.283	0.117	0.302	0.287	0.174	0.167
Republic of Tyva	229226.667	0.103	0.267	0.253	0.154	0.148
Republic of Khakassia	467026.467	0.210	0.544	0.516	0.314	0.301
Altai Territory	271984.433	0.122	0.317	0.301	0.183	0.175
Krasnoyarsky kray	852376.183	0.384	0.993	0.943	0.573	0.550
Irkutsk region	615244.183	0.277	0.717	0.680	0.413	0.397
Omsk region	387407.333	0.174	0.451	0.428	0.260	0.250
Tomsk region	552320.950	0.249	0.643	0.611	0.371	0.356
Far Eastern Federal District	**695661.833**	0.313	**0.810**	**0.769**	**0.467**	**0.448**

End of the table 7
Окончание таблицы 7

Districts / regions	The average value of GDP per capita	Output per capita	Average HCQI	The contribution rate of HCQI	Average of relative output TFP	The contribution rate of output TFP
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Republic of Buryatia	276734.750	0.125	0.322	0.306	0.186	0.178
Republic of Sakha (Yakutia)	1188864.933	0.535	1.385	1.315	0.799	0.766
Transbaikalsky kray	345608.750	0.156	0.403	0.382	0.232	0.223
Primorsky Kray	545707.050	0.246	0.636	0.603	0.367	0.352
Khabarovsk kray	604753.683	0.272	0.704	0.669	0.406	0.390
Amur region	486441.417	0.219	0.567	0.538	0.327	0.314
Magadan region	1541443.567	0.694	1.796	1.705	1.035	0.994
Sakhalin region	**2114510.783**	0.952	2.463	**2.338**	**1.420**	**1.363**
Jewish Autonomous Region	372964.883	0.168	0.434	0.412	0.251	0.240

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The calculation formulas for the contribution rate of HCQ and the contribution rate of output TFP are

$(H^k)^{\frac{1}{1-\eta}}$ and $\left(\frac{\emptyset^k}{\emptyset^o}\right)^{\frac{1}{1-\eta}}$, respectively [4].

And, the findings show that the contribution rate of HCQ is higher than the output TFP in all Russian regions.

Thus, HCQ has a significant impact on per capita output, economic growth, and regional income disparities. Compared to the Central and Northwestern regions, the share of TFP output is higher in the Ural federal region. The Tyumen region has higher per capita production than the other two regions. The share of HCQ in output per capita is also higher than the TFP. Now we look at how changes in CoHC and nCoHC productivity, as well as HCQI, affect per capita output growth. We investigate how changes in CoHC and nCoHC productivity affect average years of schooling and total output in a region to draw conclusions that could aid government policymaking. Many authors stated that the ratio of the subsequent equilibrium state to the initial equilibrium state can be used to express the change in human capital productivity, i.e.,

$\hat{h}_i^k = \frac{h_i^{k'}}{h_i^k}$, where k and k' represent the prior and subsequent equilibrium states, respectively [6].

We will investigate the impact $\left(I_{kt}^{hc}\right)$ of changes in the productivity of CoHC and nCoHC, as well as the trend of the human capital quality index, on the increase in total output (GDP production) per capita. Our research contributes to a better understanding of CoA and nCoA, as well as HCQI in Russia, which could help guide education investment policy in Russia and its regions.

It is demonstrated that indicators of human capital quality have improved in several territories, with HCQI indices approaching 1.000 (that is, closer to the leading region – Tyumen) – the Central Federal District (0.959 and 0.911), the Northwestern Federal District (0.906 and 0.860) (Table 5), and the Far Eastern Federal District (0.810 and 0.769) (Table 6). However, despite increasing educational expenditure in these places, improved human capital

metrics do not contribute to higher economic growth because all graduation rates are less than 1.000 (Tables 5–7).

The reason could be a disproportionate emphasis on CoA. A balanced focus on CoHC and nCoHC development based on economic sectors' needs and demand may be most beneficial in driving the region's economic growth. It is necessary to implement a calculation using the parameters of the empirical model (10). Scholars have widely used Barro and Sala-i-Martin's economic growth model to understand the relationship between human capital and REG [24, 25].

$$lin(y_{kt}) - ln(y_{kt-1}) = I_{kt}^{hc}$$
$$I_{kt}^{hc} = \alpha_1 lin(y_{kt}) + \alpha_2 ln(HCQI_{kt}) + \alpha_x X_{kt} + \\ + \mu_k + \mu_t + \varepsilon_{kt}, \quad (10)$$

Where: y_{kt} is the per capita output of region k in period t; $lin(y_{kt}) - ln(y_{(kt-1)})$ is per capita output change from period (t-1) to (t); HCQI is the core variable under investigation; X_{kt} is a set of control variables. μ_k and μ_t are fixed effects controlling for regions and years, respectively; ε_{kt} is a random perturbation term [16].

However, the sample size for cross-sectional regression estimation is frequently insufficient and may result in bias due to variable omissions. In recent years, research has successfully used panel data to estimate growth models to overcome such issues. The method, first proposed by Wang X. et al., has gained popularity. We estimate the equation using the two-step GMM system, as described in many studies [3, 14].

Variable selection and data description. In this paper, the primary response variable of interest is the growth rate of output per capita, which we use in the logarithmic form, $lin(y_{kt}) - ln(y_{(kt-1)})$. The HCQI is the main explanatory variable, and it is calculated using data from studied regions. Estimated HCQI values are reflected in Table 8.

The factors are specified in the above model. The investment rate ($Invest_{kt}$) is the share of GDP in gross fixed capital formation. The proportion of total imports and exports to GDP is used to calculate the degree of economic openness ($Open_{kt}$). The trade unit is around ₽934.000. Before calculating the ratios, USD figures are converted to RMB using the current exchange rate. The labor force participation rate ($Labor_{kt}$) is defined as the proportion of employers to the total population. Technical innovation level, patent applications per million people ($Tech_{kt}$).

The panel data for the studied Russian regions ranges from 2018 to 2022, and Table 8 summarizes the statistics for various variables. Economic growth is a dynamic process, with changes in growth influenced by growth levels from previous periods. Equation (10) includes autoregressive terms to account for this. We employ a dynamic panel data model. For calculation, the GMM system is used, and the estimated results are represented in Table 9. The system's GMM estimation results are consistent and correct.

Table 9 contains columns that report regression results with a different set of control variables. Column (1) considers a model with HCQI as the sole explanatory variable. At a 1% level of confidence, the HCQI coefficient is positive and significant. Additional control variables are added to the models in Columns (2–4). In all models, the HCQI coefficient is positive and significant, indicating that HCQ promotes growth in Russian regions. According to the regression results in Column (4), improvements in HCQI, employment rate, and economic openness all

Table 8

Indicators for assessing the impact of human capital on economic growth, in 2018–2022

Таблица 8

Показатели оценки влияния человеческого капитала на экономический рост в 2018–2022 гг.

Variable	Description	Observation, S	Mean	Std	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)
y_{it}	per capita GDP	89	573028.74	308844.59	115038.39	1681694.70
HCQI	Human capital quality index	89	0.373	0.104	0.237	1.276
h_c	CoHK productivity	89	0.362	0.027	0.233	0.412
h_n	nCoHK productivity	89	0.355	0.458	0.016	4.068
$(Invest_{it})$	Investment rate	89	0.253	0.0790	0.132	0.611
$(labor_{it})$	Employment rate	89	0.239	0.026	0.166	0.316
$(Open_{it})$	Economic openness	89	0.146	0.142	0.007	0.742
$(Tech_{it})$	Technical innovation level	89	2.020	2.274	0.004	13.719

Compiled by the authors based on formula (10)

Составлено авторами на основе формулы (10)

Table 9

The impact of various human capital parameters on economic growth, in 2018–2022

Таблица 9

Влияние различных видов параметров человеческого капитала на экономический рост в 2018–2022 гг.

Explanatory variables	Explained variable: $ln(y_{kt} - ln(y_{kt-1}))$			
	One-step system GMM		Two-step system GMM	
(1)	(2)	(3)	(4)	(5)
$ln(y_{kt-1})$	-0.029	-0.039	-0.029	-0.039
	-2.81	-2.367	-5.92	-5.109
lnh_c	0.022	0.04	0.02	0.036
	0.308	0.257	0.869	0.656
lnh_n	0.018	0.016	0.018	0.016
	2.908	2.486	7.970	5.975
$ln(Invest_{kt})$	x	0.004	0.000	0.003
	x	0.142	0.000	0.277
$ln(labor_{kt})$	x	-0.007	0.000	-0.011
	x	-0.119	0.000	-0.419
$ln(Open_{kt})$	x	0.006	0.000	0.006
	x	0.775	0.000	2.122
$ln(Tech_{kt})$	x	0.002	0.000	0.002
	x	0.261	0.000	0.778
Constant	0.353	0.469	0.361	0.466
	3.284	2.738	7.081	5.987
AR(1) test value	-0.844	-0.865	-0.888	-0.905
p-value	0.012	0.014	0.011	0.014
AR(2) test value	0.538	0.706	0.59	0.727
p-value	0.109	0.098	0.094	0.073
Hansen test value	12.001	12.032	12.001	12.032
p-value	0.392	0.386	0.392	0.386
N	89	89	89	89

Compiled by the authors based on formula (10) and data from Table 8.

Составлено авторами на основе формулы (10) и данных таблицы 8.

contribute to economic growth. The coefficients for fixed capital investment and level of innovation are positive but not statistically significant.

The Russian per capita output growth rate increases by 0.19%–0.22% for every 1% increase in the HCQI. Similarly, a 1% increase in economic openness increases the rate of per capita output growth by 0.02%. The increase in employment rates raises the per capita growth rate by 0.05%–0.06%, which is significant at the 10% confidence level. The outcomes are comparable to those of the one-step GMM system. The estimated coefficients, on the other hand, have a higher level of significance. The estimated coefficients of HCQ, employment rate and economic openness are significant at the 1% confidence level. If the HCQI rises by 1%, per capita output rises by 0.176 percentage points. A 1% increase in the employment rate boosts economic growth by 0.047 percentage points. A one-point increase in economic openness raises per capita output by 0.019 percentage points.

Many studies indicate the importance of the HCQI per capita coefficient in ensuring the economic growth of the country and its regions. For initial per capita output, both the one-step and the two-step GMM systems produce negative and significant coefficients. This suggests that different Russian regions have experienced rapid conditional convergence in economic growth over the last decade [26].

According to the regression results, the estimated coefficients of prior per capita GDP range between 7.0 and 9.7%. In all models, the HCQI coefficient is positive and highly significant. This highlights the significance of HCQI in promoting economic growth. A section of the literature restricts human capital to cognitive capital only, which is frequently measured by school years. We can say that for every year increase in average years of schooling, the average annual economic growth rate increases by 1.4–1.7%, and the convergence rate of economic growth is between 6.9–7.5%. Our metric for human capital, both CoHC

and nCoHC are included in HCQI. Then, it's good to demonstrate that increasing the level of human capital structure by 1% increases the economic growth rate by 0.16–0.34%. Increasing the quality level of human capital by 1% increases the economic growth rate by only 0.18–0.20%. Human capital is diverse, and different types of human capital may have varying effects on economic growth.

The calculated and tabular justifications carried out in this way made it possible to construct a model of the influence of various types of human capital on economic growth (Table 9). The model contains no second-order autocorrelation because the p-value for AR(2) is insignificant. The AR(1) p-value is significant. Hansen's test also indicates that the instrument variables chosen are valid. The tests show that the system GMM model is accurate and consistent in its estimation. Columns (1) and (2) in Table 8 show the estimation result of a one-step system GMM, while Columns (3) and (4) show the estimation result of a two-step system GMM [27].

The table clearly shows that nCoHC productivity coefficients are positive and significant at 1% in all four columns. The CoHC productivity coefficient is positive in all four columns, but only in the two-step GMM is it significant. When nCoHC productivity rises by 1%, the rate of per capita output growth rises by 0.04–0.05%. When control variables are included, the cognitive human capita productivity coefficient rises from 0.05 to 0.09%, in columns (3) and (4).

Our findings suggest that both CoHC and nCoHC productivity promote economic growth. When the coefficients are considered, CoHC has a larger effect on economic growth in terms of magnitude. Various regions could expand based on their cognitive and non-cognitive human productivity levels. In Column 4, the coefficients of economic openness and technological innovation are both positive and significant.

A negative and significant coefficient of the AR(1) variable in Figure 1 indicates economic growth convergence. The regional differences in economic sectors focus, government intervention, and economic development levels exist within Russia. The influence of explanatory and control variables may differ across regions. Furthermore, any policy recommendation made by the government must be based on a regional analysis. For the analysis of the impact of HCQ on REG the federal sample was subdivided into 8 major regions. This study examined the impact of HCQ on economic growth in Russia's Eastern, Central and Western districts.

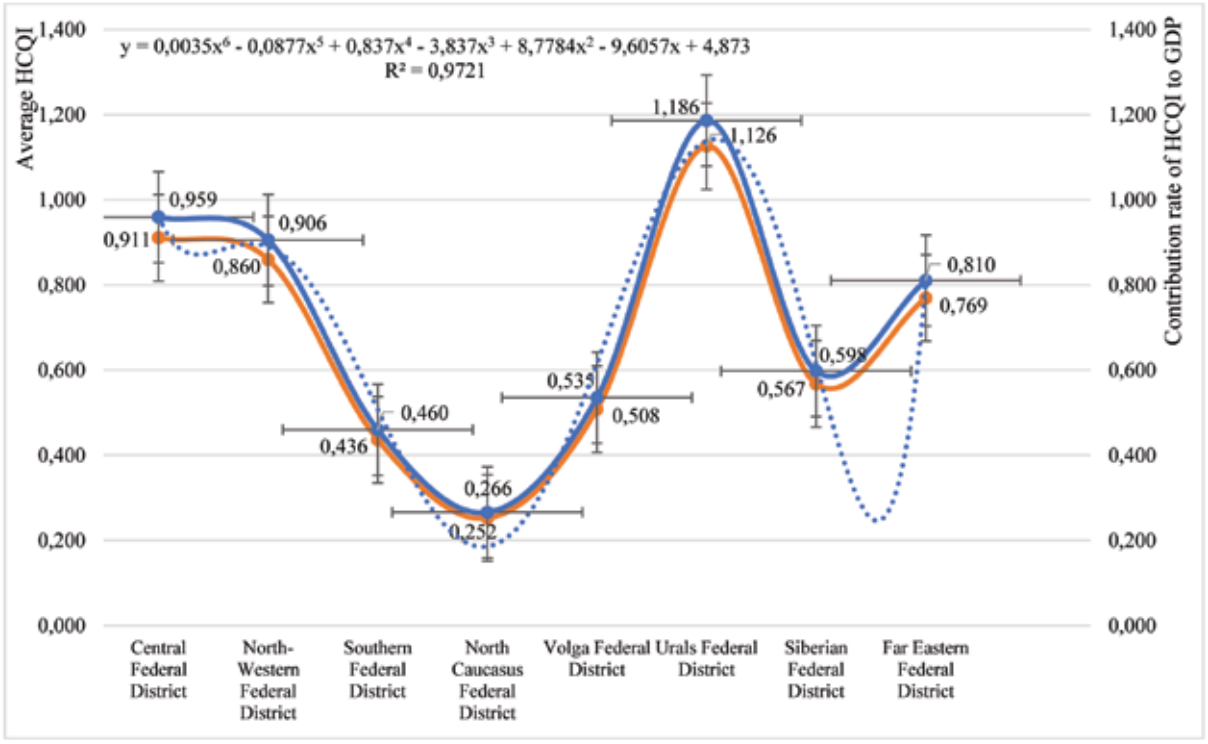
Table 7 and Figure 1 show the extent to which HCQ influences the rate of per capita output growth in different regions. The effect of three regional factors on economic growth: human capital, labor force, and technological innovation. Improving regional HCQ in the Central, Far Eastern, and Southern Federal Districts has a significant economic impact. The extrapolation of the mentioned results explains the extent to which HCQ influences the per capita output growth rate in different regions. Improving the HCQ in the Central and Far Eastern Federal Districts has a significant impact on economic growth.

The rate of per capita output growth in the Far Eastern and Southern Federal Districts and regions of the Northwestern Federal Districts is significantly influenced by CoHC. When the productivity of CoHC increases by 1% in the western region, the economic growth rate increases by 0.1266%. The CoHC coefficient, on the other hand, is not significant in the Central Federal District. Only in the Central Federal District is the nCoHC coefficient significant. When nCoHC productivity rises by 1%, the Central Federal District's per capita output growth rate rises by 0.0153%. In the Far Eastern Federal District, the investment coefficients, CoHC, employment rate and level of technical innovation have the greatest impact on per capita output. The most important factor influencing economic growth in the Western region is CoHC, followed by an increased investment rate [28].

Despite controlling for a variety of economic variables, our general findings on the impact of CoHC and nCoHC are consistent across the three Russian regions. Against the background of all this, one of the most important conclusions follows that the parameter human capital quality acts as a factor determinant of economic growth in Russia as a whole and its regions in particular (Fig. 1).

Figure 1 systematically reflects the direct dependence of the economic growth of Russia and its regions on the dynamic trend in human capital quality. The disparity in economic growth across the country can be explained by the different levels and disproportionality of human capital. The 6th-degree polynomial equation clearly shows this relationship ($y = 0.0035x^6 - 0.0877x^5 + 0.837x^4 - 3.837x^3 + 8.7784x^2 - 9.6057x + 4.873$) with a reliable Fit Ratio ($R^2 = 0.9721$) (high dependency).

The disparity in the magnitude and significance levels of variables may be attributed to the regions' vastly different sectorial, economic and social structures. Russia has an uneven spatial distribution of industries and uneven regional development after more than a decade of rapid economic growth. The levels of economic development in the Central Federal District and the Northwestern Federal District differ significantly. The region generates more than 65% of the national GDP. These factors could explain the high impact and significance of the investment rate and CoHC coefficients [27, 28].



Note:

Average HCQI, Contribution rate of HCQI on GDP, Polynomial function 6th degree of the impact of HCQI on GDP. The horizontal lines indicate the marginal limits to the aggregate growth output and GDP if the parameters of HCQI improved.

Compiled by the authors based on Table 5.

Fig. 1. Factor trend of dependence of economic growth on human capital quality index

Составлено авторами на основе таблицы 5.

Рис. 1. Факторный тренд зависимости экономического роста от индекса качества человеческого капитала

From an economic point of view, the Central, Northwestern and Far Eastern Federal Districts create prerequisites for the development of the human capital of the country and its regions. The region's economic development is constrained by a lack of access to natural resources and rural poverty problems. This explains why the CoHC coefficient for most regions is insignificant. Many regions do not have the same quality of human capital, and sectoral and economic advantages as the advanced regions of the country. The CoHC coefficient has the greatest impact on per capita growth in many regions.

It should be noted that additional research is needed on a few of issues covered in the context of the challenges we have researched. As the foundation for managing the risk of labor productivity decline in the country, the objectives should be the development of a system of criteria and indicators of human capital quality, the management of cognitive and non-cognitive parameters of human potential, and the assessment of its optimal structure. First Simultaneously, it will be critical to determine how variables that restrict labor market disproportions operate, encouraging creative approaches to the creation and evaluation of the effects of human capital quality on the overall trend of economic development of the country and its regions.

Conclusions and Relevance

Human capital in Russia has switched to the mode of qualitative development. At the same time, the economy of the country and its regions is driven by innovations supported by human talent. To develop talents, modernize the structure of economic sectors and create a new impetus for economic growth, the new development regime requires a strategic allocation of resources, which gave rise to a study of the relationship between human capital and the economic growth of Russia and its regions.

Based on the results of the study, the approach to calculating human capital has been refined, based on years of education, and includes both cognitive and non-cognitive components, measuring CoHC and a realistic HCQI indicator based on a weighted value of cognitive and non-cognitive productivity.

Disproportionate investments in the development of cognitive abilities lead to a proportional return on production per capita.

In Russia, significant regional differences in HCQ are observed in many investigated Russian regions and new entities. This is primarily reflected in sparsely populated (in terms of population density) regions of Russia – Chukotka Autonomous region (0.07 persons/km), Nenets Autonomous region (0.25 persons/km) and Magadan region (0.30 persons/km), etc.

In Russia, CoHC productivity has a greater impact on output per capita than nCoHC productivity. The coordinated development of CoHC and nCoHC determines the future pace of economic development. The disparity in human capital productivity in 89 Russian regions and news entities cannot be explained solely by the average number of years of education. Regions with more training time may not have higher CoHC abilities. In many regions, the HCQI level is higher than that measured by the average education. This is because the average schooling and academic periods reflect only CoHC, while HCQI reflects the quality of human capital from both cognitive and non-cognitive points of view. It also demonstrates the importance of cultivating nCoHC to improve the quality of life in various Russian provinces and cities.

The Russian educational system is primarily engaged in the development and research of CoA. While academic performance reflects students' cognitive abilities, many important nCoHC are overlooked. Rethink the country's education system and talent selection methods, as well as create a comprehensive assessment system to promote the accumulation of nCoHC. Local authorities should prioritize personal development and the cultivation of CoA and nCoA. At the same time, investments in non-cognitive skills should be rewarded with better non-cognitive activities.

This limits the scope of this study to analysis at the provincial level. The availability of data at the city level can expand and enrich the model and empirical analysis. Education policy should improve exam results, the number of graduates and the average length of schooling, considering whether the supply of human capital corresponds to the demand in the economic structure. By leveraging different types of human capital parameters, this initiative could help meet economic development needs while reducing inconsistency and improving the efficiency of human capital distribution across the country. The sectoral structure of the economy has been transformed from traditional to modern with an emphasis on the development of high-tech sectors with high added value. Economic development requires both CoHC and nCoHC, and balanced development can contribute to overall production growth in various regions of Russia.

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