Contribution of human capital to the economic potential of the region

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Abstract. Rapid technological renewal and digitalization of the economy entail transformation of labor relations and an intensive change in the content of labor. The current reality forces us to revise our views on methods of assessing the social and labor sphere and the human factor in the economy. Human capital is regarded as a generally recognized factor in social and economic development. The results of numerous studies of human capital do not yet provide an unambiguous answer about the degree of its direct impact on the nature and dynamics of economic growth. At the same time, a review of the results of many empirical studies yields a conclusion about a stable relationship between human capital and the dynamics of economic development. In the study of human capital, the significance of the region is very high, since the behavioral, activity and systemic characteristics of the development of society, including economic potential, are formed primarily at this level. To identify the prerequisites and conditions that affect the formation of regional human capital, the analysis of the state and development trends of human capital should be supplemented with the characteristics of the socio-economic environment, where this process takes place. The authors use an updated version of the MRW model to assess the contribution of the human capital in Kaliningrad region, the Russian exclave, to its socio-economic development, and to determine the parameters of the socio-economic development of the region that can be treated as an integral part of its human capital. The accumulated human capital realized through labor potential becomes in turn a key factor in the economic development.

1. Introduction

The most important strategic task of the Russian regions today is the formation of an innovative economy based on knowledge, professionalism and creative potential of people, which is the content of the economic category 'human capital'. The concept of human capital stemmed from the evolution of research in the social and labor sphere that generalizes the development of categories of labor force, labor resources, intellectual and social capital, and labor potential [1]. The American economist D. Minser defined this term for the first time in 1958 as a set of knowledge, skills, and abilities used to meet the diverse needs of a person and society as a whole [2]. At present, human capital is considered as a generally recognized factor of social and economic development. It includes the qualification potential (education, knowledge), the quality of the workplace and production environment, intellectual technologies and management tools, which ensure effective use and reproduction of labor potential as a growth driver.

The first attempts to formulate theoretical and methodological approaches to consideration of human resources as a form of capital can be found in studies by such classics of economic theory as A. Smith, W. Petty, J.B. Say, N. Senior, F. List, J. von Thünen, E. Engel, L. Walras, I. Fischer,

A. Marshall, and others. However, an integral neoclassical theory of human capital was formed only in the second half of the twentieth century thanks to the efforts of T. Schultz, J. Mintzer, G. Becker, M. Friedman, M. Spence, R. Barro, H. de Groot and many other researchers. At present, theoretical and methodological problems of various interdependencies of human capital and socio-economic development of countries, individual regions and territories are the subject of numerous studies, both theoretical and empirical.

An outstanding contribution to the development of scientific knowledge about human capital and its economic impact was made by Soviet and Russian scientists such as A. Baranov, V. Basov, V. Gimpelson, E. Gvozdeva, A. Dobrynin, S. Dyatlov, T.I. Zaslavskaya, A. Lukyanova, V. Martsinkevich, I. Maiburov, P.A. Minakir, S. Konovalova, D. Nesterova, E. Polishchuk, S.G. Strumilin, M. Sonin, I. Soboleva, I. Tulchinsky, T. Shterzer, and others. They created a scientific basis to study the formation and development of human capital in the context of transformation of the domestic economy with regard to the regional diversity and spatial and economic characteristics of Russian regions. The results of the economic and mathematical analysis of the aggregated effect of human capital and its individual characteristics on various processes of the development of the Russian economy are of considerable interest. The published findings of these studies indicate that human capital is the major factor of economic growth, which is no less important for regional development than physical capital and natural resources [3]. The studies by modern authors contain convincing data on the effect of individual characteristics of human capital on the productivity of regional technological processes and increasing social sustainability in the context of the digital transformation of the economy [4]. A number of studies address the search for directions for development of individual components of human capital due to changes in the regional ecosystem, including the level of digitalization, improved life quality, development of social and IT infrastructure, and changed quality of management. In conditions of significant spatial economic differentiation of Russian regions, the basic conditions for reproduction of human capital affect the disproportions in the development of its individual components, in both qualitative and quantitative terms [5, 6]. Thus, the analysis of the state and development trends of human capital should be supplemented with characteristics of the socio-economic environment where this process takes place to identify the prerequisites and conditions affecting regional human capital formation.

This environment is not static; it changes dynamically and affects not only the conditions for human capital formation, but also determines its value at one time or another. The results of some studies show a stable impact of motivational processes on the labor potential [7, 8]. Thus, many parameters of the socio-economic development of the region can be considered as an integral part of its human capital. The socio-economic development of the region can be theoretically interpreted as a process of expanded reproduction based on structural and qualitative changes in the economy and in production forces. It employs the entire set of factors and driving forces of social development, which include science, education and culture, and many other components that form the essence of the 'human capital' concept. However, the socio-economic development not only relies on human capital factors, but it actively forms these factors, since the socio-economic development of the region is aimed at increased well-being of the population, increased quality and availability of educational, medical and social services, and increased level of environmental security.

2. Review of approaches to the study of human capital at the regional level

Aggregated models are used to assess human capital due to an extremely large number of parameters to be taken into account when assessing factors and the state of the environment affecting human capital formation, as well as strong correlation between these factors.

The methodological basis of such models is quantitative assessment, mainly in the form of determination and analysis of the dynamics of a specified set of indicators. Thus, the parameters to be assessed are related to education and health care system; the proportion of the population with vocational education of different levels; dynamics of admission and graduation at universities and colleges; direction and intensity of labor flows; age structure of employment, etc. Aggregated models

are also used to study the reserve of human resources, the dynamics of investment in human capital and the return to its use [9]. However, the popularity of the indicative approach in assessment and planning does not make it free of shortcomings. First of all, this is due to its focus primarily on quantitative indicators but not on qualitative assessments. Many indicators of human capital used are informative at a macro level, and are not suitable for assessing at meso and micro economical levels.

Thus, economists use an indicative approach to characterize the 'human factor' in terms of volume and successfully assess human capital on a social and national scale, but find it difficult to perform regional economic studies (regional, urban, etc.), as well as those within enterprises and individual production teams.

The studies conducted in terms of the indicative approach do not shed light on important processes of labor potential formation, and therefore on real management in the labor sphere, which stimulates the search for more valid and verified indicators. We can cite the findings by M. Granovetter about the role of social ties in ensuring the employment as an example. The results of his empirical studies indicate an essential role of informal information in employment (more than 50% of respondents found a job using personal relations) [10].

At the same time, the main and unavoidable drawback of the indicative approach should be taken into consideration – its limited objective and quantitative characteristics to the detriment of important qualitative parameters [11], which hampers full assessment of all the constituent elements of such a complex value as human capital.

In current conditions of intensive technological renewal and digitalization of the economy, labor relations transform and the labor content intensively changes. New reality forces us to revise our views on methods of assessing the social and labor sphere and the human factor in the economy. Many conventional macroeconomic indicators, such as 'the output of goods and services produced' and 'the average number of years of schooling per capita', cannot be used to adequately assess the contribution of human capital to development. A one-sided approach is the one that focuses on the growth of goods and services production as an indicator of an increased level and quality of life, but it ignores more significant non-economic factors of development. The experience of a number of countries with economies in transition shows that the standard of living can be low with high values of individual indicators of economic growth [12], and vice versa, a high standard of living can be recorded with insignificant indicators of economic growth.

Thus, the modern theoretical and methodological basis for the study of human capital includes a large number of approaches, models and methods that attempt to cover various aspects of functioning and development of human capital, its interaction with other components of socio-economic and social development, as well as reflect different views of researchers.

Numerous studies in different areas and a variety of approaches, findings and conclusions indicate that human capital reproduction is a complex and diverse category that requires additional studies. In our opinion, none of the existing models can comprehensively and fully assess the impact of human capital on the economic potential of the region. Therefore, the most complete and comprehensive understanding of the state and trends of human capital as an essential component of sustainable regional development requires an approach to both quantitative and qualitative assessment of the dynamics of its main components. These components primarily include regional labor potential and labor resources, their structure and dynamics, and parameters that diversify the quality of workers in terms of their compliance with the requirements of the modern economy. Human capital greatly depends on conditions of its functioning; therefore, an important aspect of its study is regional social policy, which forms the environment for human capital maintenance and development. Finally, the third main area of analysis is the impact of human capital on basic indicators of the region's competitiveness in the national and global aspects, which determine its most effective specialization in the division of labor. These research areas can provide an objective idea of the state and development trends of regional human capital as an integral part of the regional socio-economic potential.

From a practical perspective, these areas of analysis and the totality of its indicators are chosen due to availability of data required to assess human capital and its contribution to the socio-economic

development. The main source of data for this analysis is publicly available information about the complex of economic and social indicators collected by the Federal State Statistics Service, which ensures high reliability of the results and allows for effective and regular monitoring of these indicators over a long period of time, both in retrospect and in perspective.

3. Assessment of the contribution of human capital to the economic potential of Kaliningrad region

In most theoretical concepts, human capital is interpreted as a major factor in economic development, including labor resources with a certain level of education, technologies and tools for intellectual and productive labor, and quality of everyday and professional (labor) life of people, which ensure the development of human capital as the main factor of socio-economic advances. The theory of human capital considers personal characteristics that affect income and form surplus value. Most often, these characteristics include the level of education, creativity, health, professional skills, and labor mobility. Most of the studies in this area focus on the benefit from investment in education.

Generalized results of numerous studies of human capital yield a number of theoretical assumptions about the nature of the cross-impact of the human capital development and regional socio-economic development. First, the educational level of the population and its addiction to advanced training and self-education affect the scientific and technical level and create prerequisites for the growth of efficiency and productivity through innovation and Hi-Tech in the country or its regions.

Second, investments in education quality make human capital more efficient and highly productive, and ensure business development and growth of the income of the population.

Third, development of human capital contributes to strategic stability and further technological advances, and supports the innovative development of the region to create a reliable basis for solution of many socio-economic problems.

A number of methods can be used to evaluate the effect of human capital on the economic development of countries and regions. The most widely-known method employs the Human Development Index (HDI), which until 2013 was known as the Human Potential Development Index (HPDI). The HDI composite index measures various aspects of life of the population in countries and regions all over the world. This index is systematically calculated for the United Nations Development Program as the most important indicator in the UN series of reports on human development. According to the calculation methodology described in detail in [13], the HDI is a complex indicator of the population knowledge, health status and the level of well-being, which can be assessed using three indices:

−   education index to assess the adult literacy rate and the share of students receiving vocational education;

−   life expectancy index used as the main aggregate indicator of life expectancy;

−   index of gross national product calculated as a set of goods and services produced in the country over a period of one calendar year and income received by organizations and citizens from abroad minus income exported from the country by foreign citizens and organizations.

The HDI indicator is widely used by government authorities as a tool for assessing effectiveness of investment in human capital. Despite the fact that the HDI is a tool used to compare the standard of living in different countries and regions, including its versions adapted to assess the quality of life and well-being of the population of the Russian Federation, its use in assessment of the relationship between human capital and the economic situation in the regions is doubtful. The main disadvantage of the HDI and its numerous modifications is that it is primarily a macroeconomic indicator, and its calculation technique cannot be used for full consideration of specific social and economic problems at the regional level.

Within the indicative approach, the corpus of comparative studies of regional economies is of relevance [14].

It should be noted that the results of empirical studies do not yet give an unambiguous answer to the question of direct effect of human capital on the nature and dynamics of economic growth.

Comparison of indicators of human capital and socio-economic development does not take into account the factors affecting these indicators, and assessment of the role of human capital may be overestimated or vice versa. These factors include management effectiveness, social communications, the level of technology and digitalization, etc. The use of the results of international survey studies causes difficulties due to different interpretations of one indicator, for example, the level of literacy, or the effectiveness of innovation and investment in intellectual potential.

Nevertheless, the results of many empirical studies show a stable relationship between human capital and the dynamics of economic development in countries [15] and regions, including the entities of the Russian Federation. Therefore, assessment of the contribution of human capital to the economic potential of regions is an urgent task.

The experience gained in using the Mankiw-Romer-Weil model, neoclassical model of exogenous economic growth [16, 17], seems interesting. In contrast to other models, it considers human capital as a component of the production function:

$$Y = K^{\alpha} \cdot H^{\beta} \cdot (A \cdot L)^{1-\alpha-\beta}, \tag{1}$$

where Y is production function, K is physical capital, L is labor (amount of labor resources), H is human capital, A is the level of technology [18].

Provided that transformation of income into physical capital, human capital and consumption does not entail additional costs, the depreciation rate of human capital coincides with the depreciation rate for physical capital, and return to reproducible resources is found to be diminishing, that is $\alpha + \beta < 1$, transformation of Y (1) yields a logistic equation that characterizes the production of goods per person employed in the economy [16]:

$$ln\left(\frac{Y}{L}\right) = \ln A_0 + gt - \frac{\alpha+\beta}{\gamma}\ln(n + g + \delta) + \frac{\alpha}{\gamma}\ln(s_k) + \frac{\beta}{\gamma}\ln(s_h), \tag{2}$$

where α is the share of physical capital, β is the share of human capital, γ is the share of labor, provided that $\gamma = 1 - \alpha - \beta$.

The competitiveness of any region largely depends on its intellectual potential, the level of development of science and innovations, and their integration into industry, management, and education. One of the key drivers for modern economical development is technology and knowledge-based innovations. The innovative sector of the economy and the workers employed are the main sources for formation of high-quality human capital.

Equation (2) determines the specific volume of the production cost depending on exogenous factors (technology and changes in labor supply) and the accumulation rate. In this case, two types of the accumulation rate are used: for physical (s_k) and for human (s_h) capital separately. Taking into account that the coefficient A_0 includes the constant a and unaccounted variables ε in a stationary state, regression equation (2) will take the form:

$$ln\left(\frac{Y}{L}\right) = a + \frac{\alpha}{\gamma}\ln(s_k) + \frac{\beta}{\gamma}\ln(s_h) - \frac{\alpha+\beta}{\gamma}\ln(n + g + \delta) + \varepsilon, \tag{3}$$

To assess equation (3) with regard to the economical situation in Kaliningrad region, the exclave region of Russia, publicly available information over the period of 2013–2018 from official reports of state statistics bodies can be used. The main input data used to parameterize the equation describing the contribution of human capital to the economic potential of Kaliningrad region are provided below.

In this case, the independent variable (Y / L) is the quotient of dividing the gross regional product (GRP) and the number of people employed in the regional economy (Table 1).

Table 1. Specific output in the regional economy.

	2013	2014	2015	2016	2017	2018
Y (GRP in 2013 prices), million rubles	275885.8	296030.4	310166	319142.9	325597.8	350822
L (employment), thousand people	476.5	477.8	478.2	476.9	477.3	479.9

Y / L		578983.8	619569.8	648611.5	669203.1	682103	713612.6

The depreciation rate δ is assumed to be 5% based on averaged and aggregated data on the calculation of depreciation charges in the Kaliningrad economy from 2013 to 2018. The rate of change in labor supply n is calculated as the average annual dynamics of the number of workers employed in the regional economy (Table 2).

Table 2. Dynamics of growth in the number of workers employed in the regional economy.

	2012	2013	2014	2015	2016	2017	2018
L (employment), thousand people	476.7	476.5	477.8	478.2	476.9	477.3	479.9
n (rate of change in L)	-	1.000	1.003	1.001	0.997	1.001	1.005

The share of investments in fixed assets relative to the GRP is used as an indicator of accumulation of physical capital s_k. The reference data of Rosstat are used as an information source to determine this indicator (Table 3).

Table 3. Investment in fixed assets relative to GRP ratio.

	2013	2014	2015	2016	2017	2018
s_k (investments in fixed assets / GRP)	0.249	0.203	0.197	0.232	0.312	0.347

Increased labor efficiency as a result of the increased quality of labor resources is one of the main economic results of building up human capital.

The data used to calculate the rate of human capital accumulation are presented in Table 4.

Table 4. The rate of human capital accumulation in Kaliningrad region.

	2013	2014	2015	2016	2017	2018
Number of students enrolled in programs of higher and secondary vocational education, thousand people	46.3	44.6	42.3	41.8	41.3	40.9
Average annual population of the region, thousand people	952.5	966.0	972.7	981.4	990.5	998.4
s_h (the rate of human capital accumulation is the share of students in total population)	0.049	0.046	0.043	0.043	0.042	0.041

Officially published Rosstat data on dynamics of the labor productivity index in constituent entities of the Russian Federation can be used as a direct source of data on the rate of increase in the efficiency of labor resources g. However, in addition to labor productivity, labor efficiency as a result of human capital investment can be characterized by other indicators. Therefore, it is necessary to consider alternative assessment of the quality of labor resources, for example, the growth rate of the number of highly productive jobs at enterprises of the region (Table 5).

Table 5. Indicators for assessing changes in the efficiency of labor resources in the regional economy.

	2013	2014	2015	2016	2017	2018
Labour productivity index, %	100.6	104.2	99.4	102.2	101.6	103.1
Number of highly productive jobs, thousand units	108.7	111.5	103.9	97.9	99.0	110.8

Data on the average annual cost of fixed assets and GRP were used to calculate the coefficient of physical capital elasticity α. According to these data, the coefficient value is 0.44. In this case, the coefficient of labor elasticity γ is equal to 0.21.

The main parameters of the MRW model are estimated using the robust (stable) regression method, which eliminates the impact of 'outliers' in the sample when setting up the model. Table 6 shows the variables estimated in equation (3) using the above data.

Table 6. Estimation of MRW model variables[a].

$\ln(Y/L)$	13.27	13.40	13.50	13.60	13.68	13.48
$\ln(s_k)$	-1.39	-1.59	-1.62	-1.46	-1.16	-1.06
$\ln(s_h)$	-3.02	-3.08	-3.15	-3.15	-3.17	-3.19
$\ln(n+g+\delta)$	0.07	0.07	-0.02	-0.05	0.02	0.16
$\ln(n+g+\delta)$	0.13	0.15	0.08	0.03	0.04	0.15

[a]Two approaches were applied to choose the indicator *g*. The first approach is based on the rate of change in the number of highly productive jobs. The second one is based on labor productivity.

The main parameters of the model and the coefficients before the independent variables can be used to derive an empirical equation that models the regional per capita output depending on the accumulation rates of physical capital and human capital, the growth rate of labor efficiency and other key factors:

$$ln\left(\frac{Y}{L}\right) = 2.09 \cdot \ln(s_k) + 1.67 \cdot \ln(s_h) + 3.76 \cdot \ln(n + g + \delta) + a + \varepsilon, \text{ (4)}$$

with the average calculated values of independent variables characteristic of the state of the economy and human capital in Kaliningrad region in 2013–2018: *s_k = 1.38*; *s_h = 3.13*; *(n + g + δ) = - 0.04*; *(a + ε) = 13.49*.

The factors in empirically derived equation (4) are widely dispersed in values of the F-statistic. This is due to the extremely short observation period, and small size and high volatility of the regional economy that features significant fluctuations over a short period. Therefore, it is necessary to further study the key parameters of the model, the factors of human capital that can potentially affect the average per capita output.

The dynamics of the number of workers with higher education and mid-level specialists employed in the economy in Kaliningrad region and the dynamics of the number of highly productive jobs available in regional companies are considered as additional parameters that expand understanding of the degree of human capital effect on the economic indicators of the region. Similar to model (4), per capita output calculated as the ratio of GRP to the number of people employed in the economy acts as the main indicator that characterizes the effect of human capital on the regional economy. Figures 1 and 2 show the types of dependence of per capita output on the human capital parameters.
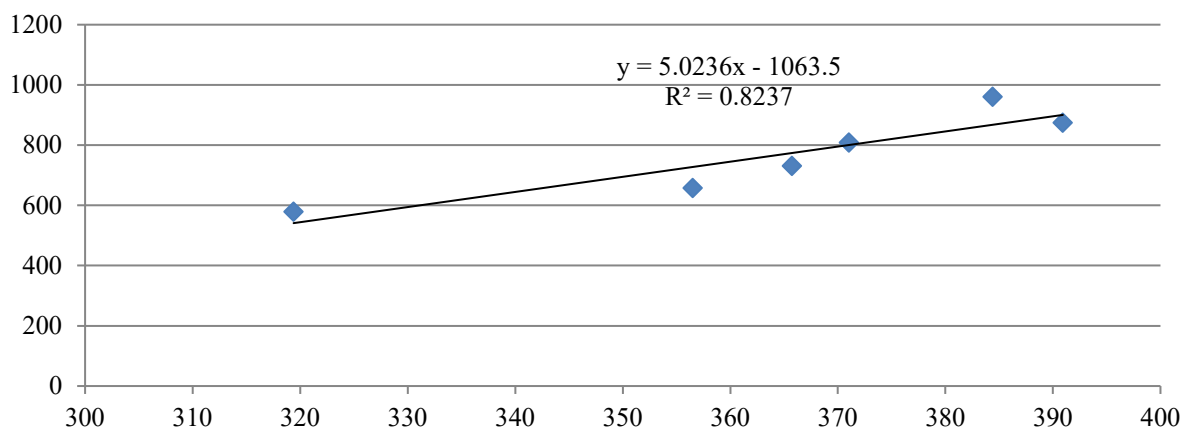
Figure 1. Dependence of per capita output on the number of workers with vocational education[b].
[b]Legends: *y = Y / L*, thousand rubles/person per year; *x* is the number of employees with higher education and mid-level specialists, thousand people.

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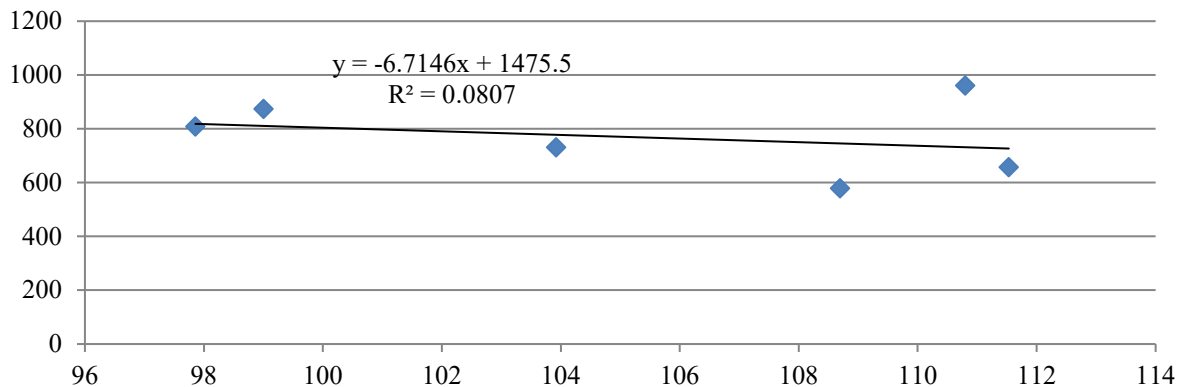
Figure 2. Dependence of per capita output on the number of highly productive jobs in the economy[c].
[c]Legends: $y = Y / L$, thousand rubles/person per year; x is the number of highly productive jobs, units.

In addition, Figures 1 and 2 show equations that describe the types of dependences of per capita output on the parameters of human capital, and the coefficients of determination that assess the effect of these parameters (explanatory variables) on the main indicator. Based on the results of evaluating the regression of the first type, the coefficient of determination R^2 was equal to 0.82, and the second regression yielded the coefficient equal to 0.08.

4. Results and conclusion

Thus, we can assume that per capita output as the main economic indicator of the region is largely determined by the qualification level of labor resources, that is, the number of workers with vocational education (and, hence, the share of these workers in the total number of workers employed in the economy). The obtained high value of the coefficient of determination for the rate of human capital accumulation in the generalized model (4) ($R^2 = 0.71$) shows that human capital (mainly in the form of highly educated workers) has a significant effect on the economy of Kaliningrad region.

At the same time, the assumption that per capita output depends on the number of highly productive jobs (the coefficient of determination is 0.08 and a weak negative dependence of the output on labor productivity, which contradicts logic) is not confirmed. This conclusion contradicts the first assumption that the success of the regional economy depends on the level of education of workers. The causes of this discrepancy require further studies. The most likely of these causes is imperfection of the methodology and inaccuracy in measuring this statistical indicator.

The estimated calculations show the following. First, such important characteristics of human capital as the rate of human capital accumulation and the number of workers with vocational education (higher and secondary) are statistically significant and have a beneficial effect on the specific value of the GRP in Kaliningrad region. Second, the estimation does not reveal any significant dependence of the region's specific GRP on the labor productivity of workers and on the number of highly productive jobs in the economy. This phenomenon contradicts the logic of modern economic development and requires further studies. Third, the estimates obtained indicate almost equal effect of physical and human capital on the economic potential of the region. This provides a basis for reconsidering the main directions of the regional economic policy and recommending the regional authorities to develop and actively implement a strategy for development of human capital.

The region as a socio-economic formation located between the societal level (society as a whole) and the primary territorial communities (settlements, cities, communities) is a highly important construct both in scientific terms and in terms of practical administration. In the study of human capital, the region is of high relevance, since behavioral and activity characteristics, and then systemic characteristics of the social development of society, including the economic potential, are laid at this level. In turn, the accumulated human capital realized through labor potential becomes a reliable basis for further economic development.

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