Integrated Assessment of Human Capital on the Macroeconomic Level

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Abstract. The key figure in all the changes that take place in society is the person, his work, creative abilities, competencies, state of health, his human capital. The theoretical analysis carried out in the article showed that today there is no perfect methodology for the integral assessment of human capital. Existing methods do not cover all structural components of this economic category and, therefore, do not objectively reflect its current state. To improve existing methods, the authors propose a multivariate model of macroeconomic assessment of human capital taking into account integral indicators of stimulating and disincentive factors overwhelming the whole set of factors. The multivariate model has been parameterized taking into account twenty-four factors on the example of statistical data of the Russian Federation for seven years. The calculations made it possible to determine the highest and the lowest levels of human capital during the study period. The modeling revealed the factors that had a negative impact on the integral indicator of the state's human capital, which may be the basis for developing programs of its development. Keywords: human capital, human capital index, macroeconomic assessment of human capital, integral assessment of state human capital

1. Introduction

In modern conditions of functioning of social production, when the dominant priorities are improving the competitiveness of the national economy, introducing new mechanisms for the formation and management of human resources, such a significant resource of socio-economic development as human capital is of great importance. The growing role of human capital is determined by many factors: the leading role of man in social production; significant influence of scientific and technological progress on the development of social production; priority of human resources compared to material resources.

2. The relevance, scientific significance of the issue with a brief review of the literature

Man acts as the main source of ideas, knowledge, their accumulation, updating and implementation. Accordingly, the role and importance of human capital as a factor in modern production is growing. Human capital is gaining key importance for building an innovative economy, which makes it necessary to measure and evaluation distinctly the state's human capital.

The general methodological basis of the study is investigation of leading foreign and domestic scientists, reflecting the fundamental principles of the concept of human capital, human development, positioning a person as the main factor in social production, G. Becker, J. Kendrick, M. Critsky, R. Nizhegorodtsev, L. Turov, S Fisher, T. Schulz [1 - 7].

Many domestic and foreign scientists, such as: E. Denison, R. Kapelyushnikov, M. Christian, B. Milner, R. Solow, and others, have dealt with the assessment of human capital [8 - 11].

3. Setting up the problem

Despite the availability of various methods for assessment of human capital, in the context of rapid changes in the economy, there is a need to be more specific about the criteria and methods for assessing the quantity and quality of human capital on the macroeconomic level. This is what predetermines the goal of the study, which is to analyze existing approaches and improve the methodology for calculating the integral indicator of the level of human capital on the level of macroeconomics.

4. Approaches to the assessment of human capital

The theory of human capital is closely connected with development of the concept of capital. A. Smith also pointed out that the capital of a society consists not only of machines, structures and land, but also of acquired useful skills of members of society, which means the person himself with his skills and abilities is also included in the capital [12]. According to V. Petty, people and their ability to produce should be evaluated on a par with wealth. Thus, a statement has been formed that people and their useful skills and abilities represent a specific capital or resource, which in its economic essence can be equated with other production resources [13]. According to T. Schulz, human capital is an economic category that encompasses the totality of the abilities, personal qualities and motivation of employees, accumulated by them through investments with the aim of generating income in future. [7].

Human capital as an economic category is complex in its structure [14]. That is why its measurement and evaluation is a rather difficult task. Nevertheless, the individual components of human capital can be estimated using traditional economic indicators, though the calculation is quite approximate due to impossibility of quantitative assessment of some of its components. The existing methods for assessing human capital can be divided into two models: a model for determining human capital based on a cost approach (at the macroeconomic level, that is the use of a system of national accounts), providing that costs include education, advanced training and retraining, as well as the cost of finding information about a new job; a model for calculating human capital based on the income (rental) approach, when human capital is considered as an asset that generates income to its owner.

To calculate the value of human capital and its constituent indicators, three main approaches are used, using the following types of indicators for analysis.

The use of natural indicators is convenient as they can be calculated on the basis of statistical data. With this approach, human capital is assessed by indicators such as education, professional qualifications, health and others. After determining the value of each component of human capital, using the system of special coefficients, corresponding points are set for each indicator. Despite all the advantages and simplicity of this methodology, when studying the individual components of human capital, a method for converting them into a single indicator has not been proposed.

Cost indicators are the most universal and reflect more accurately the structure of human capital. With their help, it becomes possible to compare the indicators of human capital of individual regions and states. With this approach to assessing human capital, the volume of investments in the healthcare system, education, the social sphere and other areas of government activity, ensuring development of human capital, should be calculated. Evaluation of human capital is also not without certain drawbacks, for example, it is impossible to assess all existing costs and fully calculate the gains received by the state from the development of human capital.

The use of relative indicators is based on development and calculation with the purpose of subsequent comparison of various coefficients, indices, ratings, ranks and points, allowing a

comprehensive assessment of human capital. So, according to the rating of human capital, cited by the World Economic Forum, in 2017 Russia took 16th place among 130 countries of the world [15].

For this rating score, the "Human Capital Index" is used, which is determined on the basis of four components characterizing:

1) level of formal education (reflects the level of literacy of the population, as well as the proportion of the population with primary, secondary and higher education);

2) the level of potential participation of the population in the state labor force (characterizes the level of unemployment, underemployment, as well as the gender gap between workers);

3) the level of development of primary education, as well as advanced training and retraining systems;

4) level of development of professional skills of workers.

It should be noted levels of the individual components of the human capital indicators of the Russian Federation differ significantly. In terms of the level of formal education, the Russian Federation takes the 4th place in the world, in terms of the participation of the population in the workforce – it takes the18th place, in terms of educational development – the 33rd place, and in terms of the development of professional skills of workers - only the 42 -th place in the world, which reflects a rather low level of using advanced production technologies [15].

Nevertheless, the methodology for assessing human capital, proposed by the World Economic Forum, does not contain such important components as factors of formation of biovital capital or capital of human health and physical condition, motivation and labor productivity. This means that the indicators of the report reflect to a greater extent the human potential, since the category "capital" implies return in the form of a manufactured product.*Style and spacing*
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5. Methodology for assessing human capital at the macroeconomic level

Formation and development of human capital is a complex and multifactorial process. Statistical analysis of 2011-2017 has made it possible to choose the most important, in our opinion, indicators. To assess the level of development of human capital in the Russian Federation, we offer the study of the following factors: demographic factors that reflect the natural and mechanical growth of the population as a physical carrier of human capital; production of gross domestic product per capita (return on human capital); indicators of level of education and innovative developments; public health factors; the average level of wages as a factor of motivating formation and development of human capital; factors of population participation in economic activity. We take the data for the assessment from statistical collections and the official website of state statistics [16-19].

The main idea of the methodology proposed for assessing human capital is the method of calculating the area of a polygon. In addition to the high degree of visualization of the advantages and disadvantages of the compared objects, the level of assessment in the form of a specific numerical value by calculating the area of the polygon can be reflected. The area of the polygon depends on the number (angle α) and the values of the complex indicators displayed on the vectors coming from the center of the figure [20].

In order to proceed with calculation of the polygon area, we will normalize all complex indicators, that is, we will bring them to a single dimensionless form on a measurement scale from 0 to 1.

Various means are used as methods of rationing. Each of them has its pros and cons. The most convenient, in our opinion, is to bring the criteria to a dimensionless form - linear transformation according to the minimax principle
Each figure should have a brief caption describing it and, if necessary, a key to interpret the various lines and symbols on the figure.

$$z_{ij} = \frac{x_{ij} - x_j^{\min}}{x_i^{\max} - x_i^{\min}} \quad u \quad z_{ij} = \frac{x_j^{\max} - x_{ij}}{x_i^{\max} - x_i^{\min}} \tag{1}$$

where $x_j^{\max}$ – maximal row element, $x_j^{\min}$ – minimal element of the series, x_{ij} – normalized element of the series.

The closer the calculated value of z_{ij} is to unity, the better. Thus, when conducting an integrated assessment, all factors of the development of aggregate human capital, both stimulants and disincentives are used simultaneously, without causing a conflict in the interpretation of the results. The rationing of stimulants and disincentive factors of human capital development in the Russian Federation is given in tables 1 and 2.

Table 1. Stimulant factors of aggregate human capital rationing: rationalized values.

Stimulant factors	2011	2012	2013	2014	2015	2016	2017
Gross domestic product per capita	0.0000	0.2673	0.4315	0.6304	0.7086	0.7999	1.0000
Number of occupied at the age of 15-72	0.0000	0.4484	0.3482	0.4443	0.9551	1.0000	0.8368
Number of new-borns	0.0000	0.4213	0.8391	1.0000	0.9917	0.7862	0.0000
Average nominated month salaries of employees	0.0000	0.2063	0.4066	0.5777	0.6748	0.8444	1.0000
Number of arriving to the country	0.0000	0.2526	0.5193	0.9678	1.0000	0.9031	0.9604
Number of post-graduates	1.0000	0.8482	0.6132	0.4198	0.2615	0.0769	0.0000
Number of doctorate students	0.9973	0.9951	1.0000	0.6253	0.2975	0.0000	0.0378
Graduation from post-graduate courses with theses defended	1.0000	0.9635	1.0000	0.7842	0.5046	0.2614	0.0000
Number of graduates from higher specialized educational establishments	1.0000	0.8726	0.5592	0.3712	0.5868	0.1822	0.0000
Number of graduates from secondary professional educational establishments	1.0000	0.8243	0.6523	0.4840	0.3192	0.1579	0.0000
Number of applications for patents	0.6208	0.9185	1.0000	0.5883	0.8481	0.4601	0.0000
Number of patents issued	0.0000	0.5423	0.5133	1.0000	0.7423	0.3705	0.6124
Quantity of acting patents	0.0000	0.2020	0.3995	0.6154	0.7608	0.8664	1.0000

Table 2. Factors-stimulants of total human capital rationing: rationalized values.

Disincentive factors	2011	2012	2013	2014	2015	2016	2017
Registered patients with the diagnosis they got for the first time in their life: active tuberculosis	0.0000	0.2036	0.4162	0.5180	0.5928	0.7844	1.0000
Registered patients with the diagnosis they got for the first time in their life: diabetes	1.0000	0.4539	0.5393	0.4584	0.2539	0.5416	0.0000
Diseases associated with hypertension syndrome	0.9879	1.0000	0.9243	0.7076	0.1797	0.0338	0.0000
Registered patients with the diagnosis they got for the first time in their life: malignant tumor	0.9737	1.0000	0.9278	0.4992	0.2726	0.17708	0.0000
Registered patients with the diagnosis they got for the first time in their life: psychological disorders and behavioral disorder	0.0000	0.1909	0.4727	0.5364	0.6818	0.9273	1.0000
AID diseases	1.0000	0.9405	0.8486	0.6296	0.4114	0.1292	0.0000
Number of persons qualified as disabled for the first time	0.0000	0.2052	0.4881	0.6268	0.8154	0.9762	1.0000
Deceased	0.0000	0.1946	0.5413	0.1343	0.1725	0.3485	1.0000
Persons who left the country	1.0000	0.7474	0.5605	0.1958	0.0703	0.1879	0.0000
Unemployed aged from 15 to 72	0.0000	0.7664	0.7599	1.0000	0.6374	0.6572	0.9253

According to table 1, a preliminary conclusion can be drawn that a number of factors in 2017 showed the maximum value - 1 or approaching 1, which means the most positive effect on the development of human capital: GDP per capita, average monthly nominal wage, number of valid patents , the number of arrivals in the country. However, these are just four of the fourteen factors. Moreover, half of the factors considered were on a minimum level.

As for disincentive factors (table 2), here we observe separation of factors into a half. This half shows the most positive effect on the effective indicator, the second half is absolutely negative, that is, showed a zero level.Based on our calculations, we compiled the corresponding radar diagrams, presented in figures 1 and 2. Figure 1 presents a radar diagram that allows you to evaluate human capital by twenty-four stimulating factors.
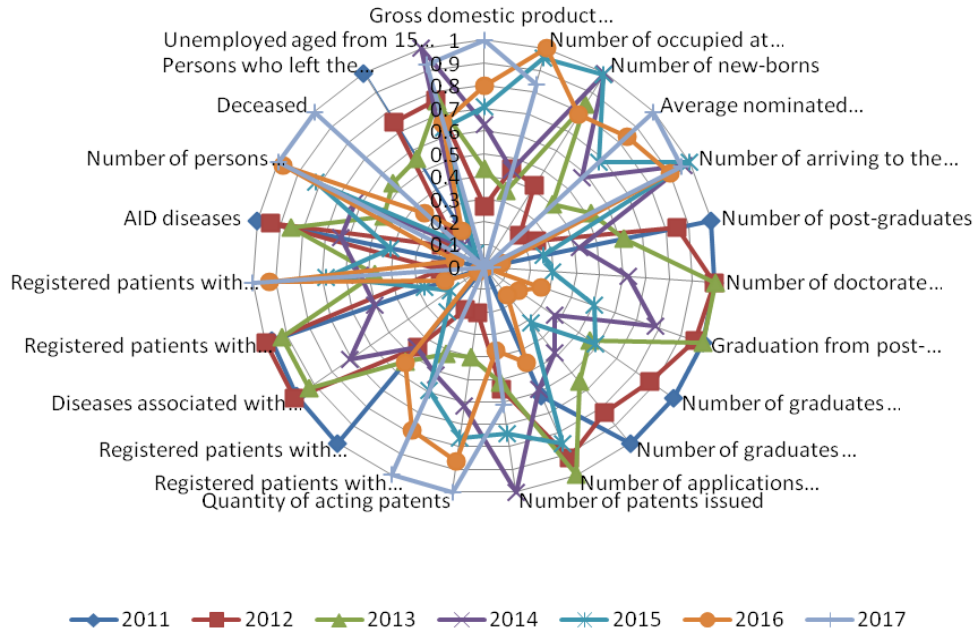

Figure 1. A multivariate model of macroeconomic assessment of human capital.

The integral indicator of the assessment of human capital is determined by the formula:

$$I_k = 0.5 \cdot \sin\left(\frac{360°}{n}\right) \cdot (x_1 x_2 + x_2 x_3 + \ldots + x_n x_1) \qquad (2)$$

where $I_к$ –integral indicator,

    n – number of indicators,

    x_i – the value of the corresponding indicator.

    The data received are presented in table 3.

Table 3. Overall integrated indicator of human capital of the Russian Federation on the basis of the selected groups of factors.

	2011	2012	2013	2014	2015	2016	2017
Integrated indicator on stimulant factors	1.2024	1.4210	1.2937	1.1839	1.2854	0.9624	0.7129
Overall integrated indicator	0.5730	0.8888	1.3179	0.8051	0.4768	0.5578	0.5658
Overall integrated indicator	0.9696	1.2467	1.3154	1.07229	0.9799	0.8213	0.6744

As the result of calculation according to the formula (2) the following data have been received. The best: (maximal – 1,3154)value of the integrated indicator of human capital development is observed in 2013. The minimal result – 0,6744 has been received in 2017 which is being analyzed.

6. Conclusion
The approaches to the human capital assessment which have been analyzed have their pros and cons. In this regard, when choosing a particular methodology one should be guided by the purpose and

specificity of a particular study, as well as the tasks of studying the aspects of the human capital development.

The author proposes a methodology for assessing human capital based on the method of calculating the area of a polygon with the calculation of the integral indicator. The factor modeling carried out in the study showed that in 2017 the Russian Federation had the lowest value of the integral indicator for human capital development.

This was caused by the negative impact of various factors. In our opinion, the first place should be given to the demographic factor, which caused the decline in the birth rate to a critical level. As concerns the education system, one should note a decrease in the number of graduates from higher and secondary vocational educational institutions, graduate students and doctoral students, graduates from doctoral studies who defended their dissertations. A great number of negative factors arise from problems in the public health care system. There are certain problems with the number of employed people.

The macroeconomic model proposed in our study for assessing the human capital development enables to identify the weakest and strongest factors, which provides the basis for developing a comprehensive program for the human capital development in the state.

References
[1]   Becker G 1975 Human Capital NY L http://methodology.chat.ru/becker1.htm
[2]   Kendrik Dzh 1978 Sovokupnyj kapital SShA i ego formirovanie Kendrik Dzh (M.: Jekonomika)275 p
[3]   Kritskij M M 1991 Chelovecheskij kapital (L.: LGU) 120 p
[4]   Nizhegorodcev R M 2013 Upravlenie znanijami v sovremennoj kompanii: strategii, struktury, tehnologii (Kirov: Avers) 256 p
[5]   Thurow L C 1970 Investment in Human Capital (Belmont)
[6]   Fisher I 1927 The Nature of Capital and Income (London : Macmillan & Co)   68 p
[7]   Schultz T 1971 Investment in Human Capital: The Role of Education and of Research (New York: Free Press) 1971
[8]   Denison Je 1971 Issledovanie razlichij v tempah jekonomicheskogo rosta (M. : Progress)
[9]   Kapeljushnikov R I 2012 Skol'ko stoit chelovecheskij kapital Rossii? : preprint WP3/2012/06 Nac. issled. un-t «Vysshaja shkola jekonomiki» (M. : Izd.   dom Vysshej shkoly jekonomiki) 76 p
[10] Christian M S 2010 Human Capital Accounting in the United States: 1994 to 2006 *Survey of Current Business* vol 87 **6** pp 78–83
[11] Mil'ner B Z 2003Upravlenie znanijami: Jevoljucija i revoljucija v organizacii (M.: INFRA-M) 177 p
[12] Smit A 2007 Issledovanie o prirode i prichinah bogatstva narodov per. s angl. V S Afanas'eva (M. : Jeksmo) 419 p
[13] Petti V 2007 Jekonomicheskie i statisticheskie raboty (M. : Direkt-Media) 324 p
[14] Kondaurova I A 2017 Razvitie sistemy professional'nogo obrazovanija kak imperativ kachestva i konkurentosposobnosti chelovecheskogo kapitala *Drukerovskij vestnik* **2** pp 93-104
[15] United nations development programme Human development reports http://hdr.undp.org/en
[16] Rossija v cifrah 2019: Krat.stat.sb. Rosstat (M.) 549 p
[17] Russian Statistical Yearbook 2018: Stat .book Rosstat (M.) 694 p
[18] Regiony Rossii 2018 Social'no-jekonomicheskie pokazateli 2018: Stat. sb. Rosstat (M.)   1162 p
[19] Oficial'nyj sajt gosudarstvennoj statistiki http://www.gks.ru
[20] Tarasova E A 2011 Optimizacija strukturnyh izmenenij v jekonomike regiona: Avtoref… dis. kan. jekon. nauk (Doneck: IJePI) 22 p