SOCIAL DEVELOPMENT

Institutional Response of Regional Socio-Economic Systems to Investing in Human Capital Increment: Assessment Technique*

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Abstract. Modern theories view human capital as the main source of economic growth. Managing the concentration of human capital to form new growth centers, provided by the Concept of the strategy of Russia's spatial development, requires the use of effective institutions. The authors' method of studying the responses of socio-economic systems to changes in the institutional conditions of human capital increment helps determine the ranking of the impact of material and institutional factors applying the methodological tools of regression analysis using dummy variables. Moreover, the study based on the proposed method makes it possible to take into account the heterogeneous nature of the socio-economic space of Russian regions in the context of human-oriented development paradigm in assessing the effectiveness of institutions based on comparative analysis of standardized coefficients of institutional variables in the regression models of the managed characteristics of human capital by regional clusters. The testing of the methodology on the example of institutional impact on the reproductive increment of the quantitative component of human capital in Russian regions for 2005–2015 has revealed the great importance of the institutional factor which ranks second by the influence of all independent variables. The estimation of heterogeneity of the socio-economic space of Russian regions was carried out using the methods of factor analysis of twelve factor-indicators of territories' attractiveness for the population, which helps form seven clusters. The characteristic of clusters is provided with the use of the author's method of a three-component vector of socio-economic territorial development. The study revealed the direct impact of the socio-natural component of regional clusters on the institutional response of socio-economic systems and the reverse impact — of the economic and inclusive component. The results can be used as analytical materials to justify the institutional measures for concentrating human capital in the planned centers of economic growth and forecasts of the need for developing the social infrastructure in the regions. The application of the developed methodological approach can be extended to the study of the impact of other institutions on the socio-economic processes.

Key words: institutional conditions, responses of socio-economic systems, human capital, cluster analysis of regions.

Introduction

Modern concepts and theories of economic growth present human capital as one of the main development factors which determines the relevance of research into its management. Studying the models of economic growth, R.J. Barro and X. Sala i Mart n conclude that "growth positively depends on the initial quantity of human capital measured by educational level and health" [1, p. 24]. *The theory of endogenous economic growth* due to human capital and its ability to self-educate (the impact of experience on productivity). — *Author's note*) provides the opportunities for unlimited growth. The models of endogenous growth by M. Frankel (1962) [2], Z. Griliches

(1979) [3] and P. Romer (1986) [4] determines the special role of human capital in economic development by the effects of knowledge and experience. In the famous work by R. Lucas *On the Mechanics of Economic Development* (1988) [5], the development model is based on the fact that human capital is a source of production and transfer of knowledge.

Many experts [6, p.12] speak about the "exceptional importance of human capital" for modern Russia. According to V. Polterovich (2015), one of the priority initiatives of the state is "building human capital" [7]. Awareness of the role of human capital in economic development has generated interest

in determining its content, reproduction, and use. Referring to the concept of human capital by T. Schultz [8] and G. Becker [9], A. Shabunova and G. Leonidova (2011) define its contents as a set of qualities that affect productivity, including "natural ability, knowledge, and skills ... creativity, and ... the motives of action providing an opportunity to generate income" [10, p. 102]. V. Iontsev and A. Magomedov (2015) understand human capital "not only a set of knowledge, educational and professional characteristics", but also "spiritual, psychophysical, and demographic qualities" inherent to each person [11, pp. 89–90]; this points to the inextricable link between reproduction of human capital and reproduction of population. Since this process is rather long and requires significant investment, G. Gagarina (2012) draws attention to the fact that significant investment in human capital "is only beyond the state's abilities" [12, p. 10].

Formation and use of the program-target approach[1] for management purposes since the mid 1990–s was aimed at improving the efficiency of reforming Russian economy. Most of federal target programs (hereinafter – FTP) adopted in the early 2000–s were directly or indirectly aimed at investing in human capital and improving the conditions of its formation at the expense of budget funds. Among them are *Prevention and control of social diseases FTP*, *Electronic Russia FTP*, *Children of Russia FTP* and others. Since 2006, a large package of target programs (included in the state programs

since 2014) has been adopted marking a new wave of social and economic reforms. Using the most common classification of types of human capital[2] [13] we note that programs adopted since the mid 2000–s were aimed at increasing the following components.

1. *Health capital*:

1.1. Development of physical culture and sports in the Russian Federation for 2006–2015 (extended to 2016–2020).

1.2. Social support for disabled people (2006–2010).

1.3. Improving road safety in 2006–2012 (extended to 2013–2020).

1.4. Clean water (2011–2017).

2. *Human capital*:

2.1. Federal target education development program for 2006–2010 (extended to 2011–2015 and 2016–2020).

2.2. Economic and social revival of indigenous peoples of the North until 2011.

2.3. Social development of a village up to 2012 (Sustainable development of rural areas for 2014–2017 and up to 2020).

3. *Intellectual capital*:

3.1. R&D in priority areas of science and technology development in Russia for 2007–2013 (extended to 2014–2020).

3.2. Development of nano-industry infrastructure in the Russian Federation for 2008–2010.

3.3. Science and science-pedagogical per-sonnel of innovative Russia (2009–2013 extended to 2014–2020).

4. *Cultural and moral capital*:

4.1. Russian culture (2006–2010 and 2012–2020).

4.2. Development of the Russian judicial system (2007–2012).

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[1] The procedure for developing and implementing Federal target programs and interstate target programs with the participation of the Russian Federation: the Russian Federation Government Decree No. 594 dated 26 June 1995. Official website of Consultant Plus company. Available at: http://www.consultant.ru/cons/cgi/online.cgi?req=doc&base=LAW&n=287235&fld=134&dst=100042,0&rnd=0.16337567839718226#0 (accessed: 15.01.2018).

[2] Smirnov V.T., Soshnikov I.V., Vlasov F.B., Skoblyakova I.V. Human capital management: study guide. Oryol: Oryol GTU, 2005. 276 p.

It should be noted that Federal target and state programs are not the only source of investment in human capital formation. For example, since 2005 the Ministry of Economic Development has been implementing a program to support small and medium business at the regional level in the form of subsidies[3] for the development of organizational and entrepreneurial capital. Moreover, a large number of funds and centers providing assistance to entrepreneurs and contributing to the formation of their entrepreneurial skills have been established [14].

In economic growth models government support and regulation measures are institutional variables[4]. Thus, the models of P. Romer (1990) [15], J. Grossman and E. Helpman (1991) [16], F. Aghion and P. Houitt (1992) [17] are based on the dependence of long-term economic growth rates on "government actions such as taxation, law support...protection of intellectual property rights" [1, p.31], as well as on the regulation of other socio-economic processes. Based on analysis of a large number of studies of modern traditional and new institutionalists V. Volchik[5] identifies "three types of influence of institutions on the economic behavior" of individuals. In addition to restrictive and informative-cognitive functions the third type of influence is realized through the teleological function[6] which involves the generation of

motivation. In the present study, the authors believe that changes in institutional conditions in conjunction with material space factors have an impact (in the form of appropriate motivation) on the economic behavior of individuals aimed at reproduction of human capital across the spectrum of its characteristics.

The research relevance lies in the need to increase the effectiveness and targeting of public administration of socio-economic development in the regions taking into account their significant differences. Identifying the institutional response of socio-economic systems forming Russia's regional space to the implementation of government measures to increase human capital is relevant not only from the standpoint of assessing the effectiveness of budget investment, but also progressive nature of areas and mechanisms for implementing the socio-economic policy. Given the heterogeneity of development of Russian territories the authors state **the purpose of the study**: to develop methods for assessing the responses of socio-economic regional systems to changes in the institutional conditions for expanding human capital. To achieve it, the following **objectives** have been set.

1. Forming the conceptual basis of the study.

2. Developing the research algorithm to synthesize the author's methods for assessing the attractiveness of the territories for the population, the classification of regions by components of human-oriented development and regression analysis tools for building models of human capital growth in regional clusters including factors in institutional conditions.

3. Testing the method through introducing one of the institutions (at the federal level) of regulation of the process of human capital reproduction in the regions.

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[3] On providing and distributing subsidies from the federal budget to budgets of Russia's constituent entities for state support for small and medium business including farm enterprises: Order of the Government of the Russian Federation no. 1605, dated 30.01.2014. Electronic Fund of legal and technical documents. Available at: http://docs.cntd.ru/document/420244200 (accessed: 15.01.2018)

[4] Institutional variables in this study are considered independent factors reflecting the regulatory impacts of the management system (e.g. government actions).

[5] Vol'chik V.V. *Institutional and evolutionary Economics: textbook*. Rosov-on-Don: YuFU, 2011. Pp. 11−12.

[6] Teleological approach is based on the provision of expediency of human behavior, actions and phenomena.

4. Allocating the region's cluster[7] through hierarchical clustering of Russia's constituent entities by characteristics of territory's attractiveness.

5. Describing clusters acting as types of regional socio-economic systems[8] from the standpoint of three-component assessment of territories' development.

6. Conducting comparative analysis of responses of types of regional socio-economic systems to changes in the institutional conditions of human capital reproduction.

7. Interpreting the results obtained to form an array of analytical materials on the responses of regional socio-economic systems to changes in institutional conditions.

Concepts and research methodology

The concept of *the new regional policy* by A. Tatarkin (2012) is based on **"the human-centered paradigm** of institutional development" implying "the forcing of the whole spectrum of investment in human development" [18, p. 29].

In the *Concept of the strategy of spatial development of Russia until 2030*[9] (hereinafter – CSSD), the prospects for improving the efficiency of using the spatial factor with respect to human resources are considered in two directions. In the model of market spacing based on the *concept of space polarization*, one of the key factors in economic development is the concentration of resources involving population resettlement to the most dynamic regions. In the model of state space preservation (retention), the most important key development factor according to the *concept of endogenous growth* is human capital whose role in ensuring sustainable development lies in: 1) forming new growth centers through the population concentration in the regions; 2) searching for ways of cost-effectively maintaining the already developed territories.

The implementation of these models of spatial development in Russia requires the development and improvement of mechanisms for managing the increase in human capital in the projected centers of economic growth. In accordance with the author's *conceptual model of functional regional system transformations* [19], this process can be provided based on the following alternative mechanisms: 1) *reproductive*, implying the process of expanded self-reproduction of human capital in the regions; 2) and *integration* associated with the function of system metabolism causing the flow of human capital from other regions.

The authors proceed from the motivational approach and the freedom of each individual to make decisions that affect changes in the human capital in regions. The first type of decision applies to people's reproductive behavior (in the broad sense) in the context of expanded reproduction of human capital. It includes both processes of fertility and growth of life potential, and the processes of learning, gaining experience, intellectual and cultural development, and moral improvement. The second type of decisions is associated with the spatial movement of an individual possessing

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[7] The region's cluster in this study is considered as a set of Russia's constituent entities formed as a result of grouping the entities by 12 socio-economic characteristics of territories' attractiveness based on the classification procedure in the IBM SPSS Statistics package with a graphical representation in the form of a dendrogram.

[8] Types of regional socio-economic systems are sets of Russia's constituent entities resulting from the classification whose socio-economic features are described from the positions of the 3 components of value-oriented development (economic, socio-natural, and inclusive).

[9] The concept of the strategy of spatial development of the Russian Federation up to 2030. Moscow, 2016. Pp. 21–25. Available at: http://карьеры-евразии.рф/uploadedFiles/files/Kontseptsiya_ SPR.pdf (accessed: 15.01.2018).

certain characteristics of human capital. According to R. Florida (2008), "clustering and concentration of talented and productive people" is a true source of economic growth [20] so regions with more favorable living conditions acquire greater competitiveness potential.

The author's **method** implies research based on **the algorithm** including the following stages:

1) selecting quantitative and qualitative characteristics of human capital assessment;

2) determining the function (reproductive or metabolic) of its increment;

3) selecting the control parameter of human capital (level of education, life potential, share of employable population, birth rate, net migration rate, etc.);

4) selecting the institution affecting the control parameter (implementation of the federal target or state program, introduction of the institution of maternity capital, changes in migration legislation, etc.).);

5) forming a data array on a dummy variable that takes the "0" value before introducing a relevant institution and the "1" value after its introduction, if the time lag from introducing the institution to manifestation of the result is less than a year (otherwise, the "delayed result" is accounted based on expert evaluation of the time lag);

6) substantiating the system of indicators to assess the regions' attractiveness based on the paradigm of human-oriented development;

7) forming data array of regional statistics for the research horizon covering the period "before" and "after" the introduction of the institution under study;

8) clustering Russian regions in terms of territories' attractiveness using the methods of multivariate statistical analysis;

9) characterizing socio-economic types of regions from the standpoint of value system of human-centered development;

10) conducting regression analysis of the human capital control parameter by regional clusters and all Russia's constituent entities with assessing statistical significance of the models;

11) forming the ranking of factor influence on the control parameter based on standardized regression coefficients;

12) conducting comparative analysis of responses of regional clusters to the introduction of the institution affecting the control parameter of human capital;

13) interpreting the obtained results to form a single array of analytical materials to assess the impact of changes in institutional conditions on the development of regional socio-economic systems.

The sequence of stages to determine the responses of regional socio-economic systems to the changes in the institutional conditions of human capital management is demonstrated in *Figure 1*.

According to the presented algorithm, the research method includes the following components.

1. *The author's method of assessing the attractiveness of a territory as a living environment* (habitat) [21, p. 25]. The attractiveness of the territory is estimated by twelve indicator-factors formed from the perspective of the motivational approach based on the system of needs and free choice. These include the physiological need for food (indicator of real earnings), housing (indicator of new housing situation), as well as for favorable climate and environmental conditions[10]. Moreover,

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[10] The opportunity to meet physiological needs in a favorable environmental situation and climatic conditions is estimated by the indicator of life expectancy in the region.

Figure 1. Algorithm of exploring responses of socio-economic systems to changes
in the institutional conditions of human capital increment in regions

Determining the characteristics of human capital (HC) assessment

Quantitative

Quality

CHoosing HC increment function in a regional system

Reproduction
(self-increment)

Metabolism
(increment through inter-regional integration)

Choosing the control parameter of HC increment (**Y**)

Choosing an institution influencing the control parameter

Socio-economic characteristics(**X$_i$**) of the region's attractiveness for living and HC increment

Forming an array of panel data of the resulting and factor features in n-th regions during the study period

Quantification of changes in institutional conditions due to a dummy variable (**Z**):
0-before introducing of institution;
1-after introducing the institution (taking into account the time lag of result)

Forming **m** clusters in regions by socio-economic characteristics(**X$_{in}$**) of region's territory's attractiveness for living

Forming models of multiple regression of the control parameter of HC increment (**Y**)
by regional space as a whole
(in n-th regions): **Y = f (X$_{in}$; Z)**;
and types of regions: **Y$_m$ = f (X$_{im}$; Z)**

Characteristics of types of regions by the three-component vector of socio-economic development of a territory, including economic (ED), social (DR) and inclusive development (ID))

Studying the responses of **m**-types of regional socio-economic systems to changes in institutional conditions of HC increment management using standardized coefficients of regression models **β(Z)$_m$**

Factor impact ranking (regarding teh changes in institutional conditions) on HC increment by types of regional socio-economic systems

Summary analysis of the dependence of response reaction of regional socio-economic systems to changes in institutional conditions of HC increment depending on type of region

Forming an array of analytical data on responses of regional socio-economic systems to changes in institutional conditions

Source: compiled by the authors.

the system of population's primary needs includes the needs for secure physical (crime rate) and social (unemployment rate and real pensions) environment. The ability to meet communication needs are evaluated according to the demographic density in the area (population density) and infrastructure development ensuring transport (road density) and communications connectivity (the volume of communication services per resident) regional space. Considering "the quality of the environment" as an integral part of "the quality of life" of the population, O. Kozlova and others (2015) note that its assessment should take into account "the degree of satisfaction of needs in creativity, self-development and self-realization of human abilities" [22, pp.183–184]. In the proposed method, territory's attractiveness from the point of view of its ability to achieve success is estimated by the degree of innovative activity of the environment (the share of innovation-active enterprises in the total number of enterprises), favorable business climate (the share of employees at small enterprises in the total number of employees) and the level of economic competitiveness (the measure of which, according to M. Porter (1993), is the export of products [23]). This method does not claim to be the most complete coverage of parameters for assessing the quality of life in the regions[11]. The authors see the following advantages:

1) the *scientific validity* of a set of indicators based on the system requirements based on content theories of motivation (Maslow (1954)

[24], J. McClelland (1970) [25], and C. Alderfer (1972) [26]);

2) *availability of data* for assessing territories based on using official statistics of Rosstat[12];

3) *focus on the modern system of values* in the society including the values of sustainable growth (economic, social, environmental) and innovative development;
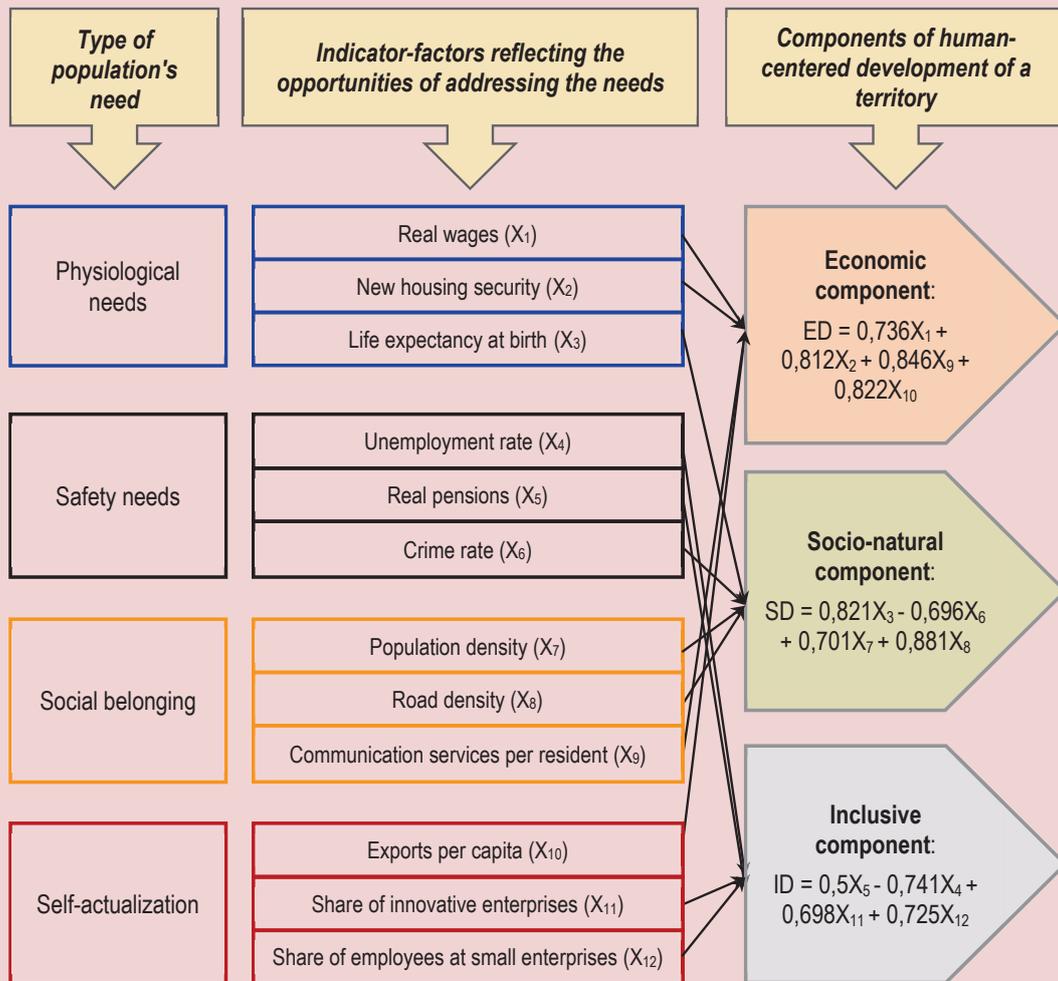
4) *flexibility of the system* of indicators which allows them to be interpreted both from the standpoint of the system of population needs and from the standpoint of territory's potentials (foreign economic, social, innovation, institutional, and infrastructure, which plays a special role in improving the comfort of life of people in Northern territories [27, p. 56]);

5) *multifunctional indicators*, which makes it possible to form components of socio-economic development of a territory and successfully interpret them on the basis of the human-cantered paradigm as demonstrated in *Figure 2*.

2. *The author's method of assessing the territory using a three-component vector of socio-economic development from the perspective of the human-centered paradigm.* Most methods for assessing the quality of life and the standard of living, as well as any methods for complex measurement of socio-economic development of territories include two stages: 1) analysis stage, which implies distinguishing a set of development components estimated by private indicators; 2) synthesis stage, where a generalized estimation takes place, most often based on weighted average values. In the proposed method, the weight of 12 particular indicators (in the form of loads on the main component) was obtained as a result of factor

[11] Various aspects of the quality of life are most fully reflected in the methodology of the RIA Rating Ranking Agency, which includes more than 70 indicators used to form the ranking of Russian regions. The limitation of the number of characteristics of territories' attractiveness in the proposed methodology to 12 indicator-factors reduces assessment complexity, but its results are close to the estimates of the mentioned Agency.

[12] Official statistics. Federal State Statistics Service. Available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/accounts/ (accessed: 15.01.2018

Figure 2. System of indicator-factors for assessing the attractiveness of a territory
as a living environment based on the motivational approach
and paradigms of human-centered development*

Type of population's need	Indicator-factors reflecting the opportunities of addressing the needs	Components of human-centered development of a territory
Physiological needs	Real wages (X_1)	**Economic component**: $ED = 0{,}736X_1 + 0{,}812X_2 + 0{,}846X_9 + 0{,}822X_{10}$
	New housing security (X_2)	
	Life expectancy at birth (X_3)	
Safety needs	Unemployment rate (X_4)	**Socio-natural component**: $SD = 0{,}821X_3 - 0{,}696X_6 + 0{,}701X_7 + 0{,}881X_8$
	Real pensions (X_5)	
	Crime rate (X_6)	
Social belonging	Population density (X_7)	**Inclusive component**: $ID = 0{,}5X_5 - 0{,}741X_4 + 0{,}698X_{11} + 0{,}725X_{12}$
	Road density (X_8)	
	Communication services per resident (X_9)	
Self-actualization	Exports per capita (X_{10})	
	Share of innovative enterprises (X_{11})	
	Share of employees at small enterprises (X_{12})	

* The paradigm of human-centered development developed after the crisis of 2008–2009, when social contradictions in the society worsened. In the document "Europe 2020. The strategy of smart, sustainable, and inclusive growth" the values of inclusive development related to employment, equal opportunities, access to social benefits, and individual self-realization were identified as a separate component.

Source: compiled by the authors.

analysis of panel data by Russian regions using the methods of multivariate statistical analysis in the IBM SPSS Statistics package. The resulting models of principal components were interpreted from the standpoint of the component of value-driven development, including the inclusive[13], socio-natural[14] and economic[15] component [21, pp. 26–30].

3. *Methodological tools of regression analysis using dummy variables*. The resulting feature (control parameter) is the human capital growth rate with the i-th characteristic for the n-th region. To study the influence of the institutional response in the system of indicator-factors, in addition to 12 characteristics of territories' attractiveness, an additional (13th independent variable) dummy variable is included, which reflects the introduction of the institution aimed at increasing human capital.

Most studies devoted to responses of economic actors to changes in institutional conditions (for example, the influence of the institutional environment on investment behavior [28]), are limited forecasting "the benefits" related to simulating behavior patterns or stating the changes in resulting indicators. The developed research technique

evaluates the "institutional response" based on empirical data (de facto) which characterize the changes in population's socio-economic behavior (measured by the resulting factor in regression equations) and the influence of the institutional variable on such behavior through the standardized regression coefficient of the dummy variable. Using regression analysis tools increases the degree of objectivity and information content of the results obtained through the developed methodology. The informational base of the study consists of panel data on the socio-economic development of 83 Russian constituent entities for 2005–2015.

Research results

The developed technique, whose calculation algorithm is demonstrated in Figure 1, was tested based on the indicator of reproductive growth of quantitative characteristics of human capital (birth rate). Introduced since January 1, 2007, the institution of maternity fund[16] aims to improve the conditions of human capital reproduction at the expense of the federal budget, including: 1) improvement of housing conditions; 2) recovery of educational costs; 3) recovery of costs of social adaptation of children with disabilities; 4) formation of retirement savings for mothers. Changes in the institutional conditions of reproductive growth of the quantitative component of human capital has served as an impulse for the formation of a positive trend in both natural and general growth of the population in Russia (*Fig. 3*).

The efficiency of institutional measures of using the mechanism of stimulating repro-ductive growth through maternity funds has

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[13] In the author's method of assessing the socio-economic development of the territory based on the human-centered paradigm, an inclusive component characterizes the development from the standpoint of the quality of working life, including its innovative and entrepreneurial aspects.

[14] The social component in the social-nature component characterizes the state of the regional space from the standpoint of "non-labor" aspects of the society (crime rate, development of the society, transport availability). The natural component is assessed in the context of environmental values and sustainable development through life expectancy.

[15] The economic component of human-centered development of a territory is estimated from the standpoint of the population's standard of living (in terms of real wages and new housing security), the degree of economic "servicization" (manifested, for example, in the increased volume of communication services) and its increased competitiveness (measured by exports).

[16] On additional measures of state support for families with children: Federal Law no. 256-FZ, dated 29.12.2006. Official website of ConsultantPlus company. Available at: http://www.consultant.ru/document/cons_doc_LAW_64872/ (accessed: 15.01.2018).

Figure 3. Performance of growth rates of the quantitative component of human capital
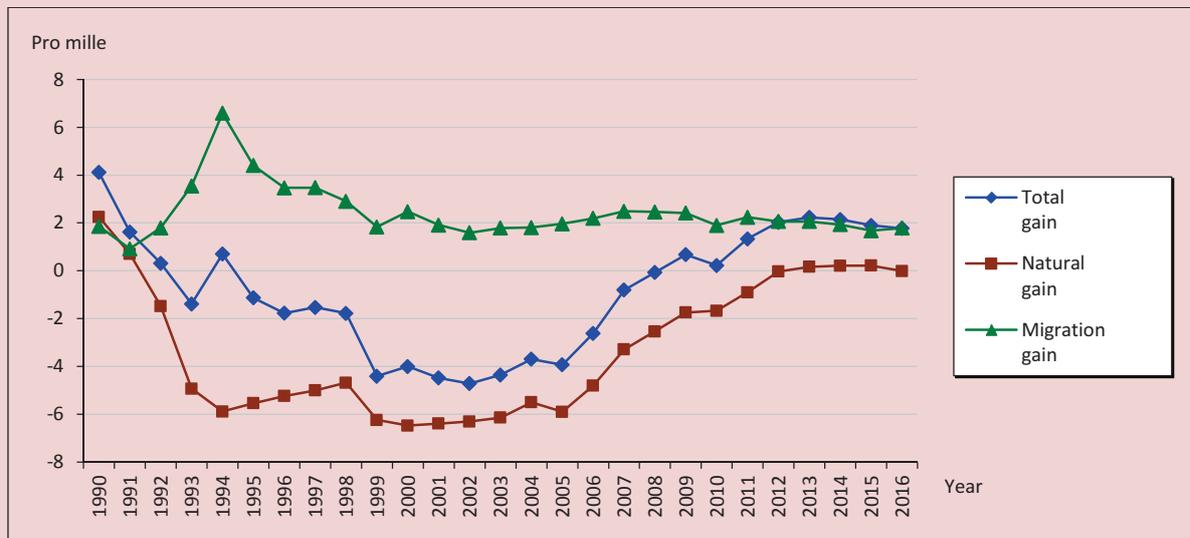
Sources: Demographic Yearbook of Russia, 2002–2017. Federal State Statistics Service. Available at: http://www.gks.ru/; Russia in figures, 2003–2017. Federal State Statistics Service. Available at: http://www.gks.ru/ (accessed: 15.01.2018).

helped overcome the downward trend in demographic component of the human capital in Russia. At the end of 2017, the President of Russia signed a Law on extending the maternity fund program to 2018—2021[17], which confirms the relevance institution choice.

Using the authors' research methodology has helped form a model of reproductive growth of the quantitative component of human capital for 2005—2015. In the regression model of reproductive growth of human capital in the whole population of Russian regions, the impact of changes in institutional conditions (associated with introducing the institution of maternal fund) ranks second in the factor ranking (with a standardized coefficient of 0.385) (*Fig. 4*).
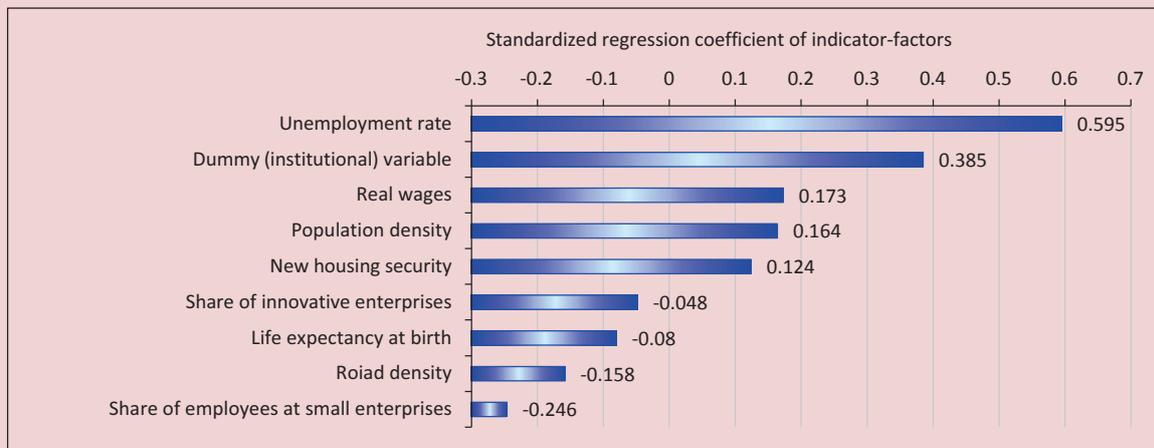
Judging by the values of standardized coefficients[18], the most positive impact on reproductive growth rate is unemployment rate (0.595). Together with factors characterizing the state of the business environment (-0.246) and innovation activity of regions (-0.048), which have the opposite effect on the birth rate, these three independent variables characterize the inclusive component of the territory development. The third most important factor in terms of the impact on the dependent variable is real wages (0.173), which, together with population's new housing security (0.124) characterizes the economic component of regional development.

Taking into account the fact that Russia's regional space is much differentiated by socio-economic characteristics of territories' attrac-tiveness, the objective to build models of

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[17] Federal law no. 432-FZ "On amendments to Federal Law "On additional measures of state support for families with children"", dated 28.12.2017. Official website of ConsultantPlus company. Available at: http://www.consultant.ru/document/cons_doc_LAW_286465/ (accessed: 15.01.2018).

[18] The standardized regression coefficient helps determine the direction and degree of influence on the dependent variable (reproductive growth coefficient) of each factor included in the model.

Figure 4. Ranking of factors affecting the coefficient of reproductive growth of the quantitative component of human capital in all Russian regions, according to standardized regression coefficients

Standardized regression coefficient of indicator-factors

Unemployment rate	0.595
Dummy (institutional) variable	0.385
Real wages	0.173
Population density	0.164
New housing security	0.124
Share of innovative enterprises	-0.048
Life expectancy at birth	-0.08
Roiad density	-0.158
Share of employees at small enterprises	-0.246

Calculated according to: Regions of Russia. Socio-economic indicators. 2006–2016. Federal State Statistics Service. Available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1138623506156 (accessed: 15.01.2018).

reproductive growth of human capital in clusters of Russia's constituent entities has been set. Using the methods of hierarchical clustering by characteristics of attractiveness of a region as a population's habitat[19] provided by the author's method [21], has formed four main clusters including Middle, Northern, Agglomeration and Southern. Based the numerous regions making up the Middle cluster, which includes 57 Russia's constituent entities, it was divided into 3 sub-clusters at a lower level of clustering (*Tab. 1*).

The names of clusters and sub-clusters within the Middle cluster are given by the authors based on the economic and geographical location and features of socio-economic development. The average standardized factor values are presented in *Table 2*.

To identify the characteristics of regional clusters (forming the types of socio-economic systems), 12 indicator-factors in accordance with the authors' assessment methodology were grouped using the principal component method into three components including economic, socio-natural, and inclusive. The results of forming the three-component vector of socio-economic development in regional clusters obtained by standardizing the indicators by their relation to the average values for all constituent entities, are demonstrated in *Figure 5*.

The clustering of Russia's constituent entities helps reveal the peculiarities of territories' development according to a three-component vector of human-centered development. These peculiarities are as follows.

1. There is a *significant differentiation in the overall level of socio-economic development*. The "separation" of the Agglomeration cluster by the level of development from other clusters (from 4 times compared to the Middle developed cluster up to 14 times compared to the Southern cluster). This amplitude is ensured through the socio-natural component which

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[19] Clustering is carried out on the basis of panel data on 12 characteristics of attractiveness of territories of 83 regions of the Russian Federation for 2005–2015.

Table 1. Clusters of Russia's constituent entities according to 12 characteristics
of development of the socio-economic regional space as a population's habitat

All Russian regions (83 constituent entities)	1. Middle cluster (57 entities)	1.1. Middle economic cluster (20 entities)	Altai Krai Arkhangelsk Oblast Astrakhan Oblast Vologda Oblast Irkutsk Oblast Kemerovo Oblast Krasnoyarsk Krai Kurgan Oblast Leningrad Oblast Magadan Oblast	Novosibirsk Oblast Omsk Oblast Orenburg Oblast Perm Krai Republic of Bashkortostan Republic of Karelia Komi Republic Republic Khakassia Sverdlovsk Oblast Tomsk Oblast
		1.2. Middle developed cluster (5 entities)	Belgorod Oblast Lipetsk Oblast Moscow Oblast	Republic of Tatarstan Chuvash Republic
		1.3. Middle balanced cluster (32 entities)	Bryansk Oblast Vladimir Oblast Volgograd Oblast Voronezh Oblast Ivanovo Oblast Kaliningrad Oblast Kaluga Oblast Kirov Oblast Kostroma Oblast Krasnodar Krai Kursk Oblast Nizhny Novgorod Oblast Novgorod Oblast Oryol Oblast Penza Oblast Pskov Oblast	Republic of Adygea Mari El Republic Republic of Mordovia Rostov Oblast Ryazan Oblast Samara Oblast Saratov Oblast Smolensk Oblast Stavropol Krai Tambov Oblast Tver Oblast Tula Oblast Udmurt Republic Ulyanovsk Oblast Chelyabinsk Oblast Yaroslavl Oblast
	2. Northern cluster (17 entities)		Amur Oblast Jewish Autonomous Oblast Zabaykalsky Krai Kamchatka Krai Murmansk Oblast Nenets Autonomous Okrug Primorsky Krai Altai Republic	Republic of Buryatia Republic of Sakha (Yakutia) Tyva Republic Sakhalin Oblast Tyumen Oblast Khabarovsk Krai XM Autonomous Okrug Chukotka Autonomous Okrug Yamalo-Nenets Autonomous Okrug
	3. Agglomeration cluster (2 entities)		Moscow Saint Petersburg	
	4. Southern cluster (7 entities)		Kabardino-Balkar Republic Karachay-Cherkess Republic Republic of Dagestan	Republic of Ingushetia Republic of Kalmykia Republic of North Ossetia-Alania Chechen Republic
	Source: compiled by the authors.			

evaluates the factor in "capitality" through the social component. Uneven development manifested in the "capitality", "periphery" and "outskirts" territories is the most characteristic feature for the Russian space.

2. The heterogeneity of space is also manifested in *different degrees of components' balance*. The territories of new industrial development (regions of the Northern cluster) are characterized by imbalance of the socio-economic development components in favor of the economic component. The territories at advanced stages of regional development (entities forming the Middle cluster), demonstrate a more harmonious development of space.

Table 2. Average standardized* values of indicator-factors of territories'
attractiveness by regional cluster for 2005–2015

Indicator-values	Sub-clusters of Middle cluster			Northern cluster	Agglomeration cluster	Southern cluster
	Economic	developed	balanced			
Real wages	1.037	1.078	0.904	1.137	1.388	0.834
New housing security	0.938	2.023	0.995	0.897	1.164	0.671
Life expectancy at birth	0.989	1.023	1.001	0.966	1.072	1.074
Unemployment rate	0.822	0.563	0.713	1.020	0.146	3.328
Real pensions	1.029	1.116	1.036	0.864	1.001	0.998
Crime rate	1.213	0.779	0.892	1.227	1.259	0.418
Population density	0.100	0.638	0.296	0.026	32.045	0.540
Road density	0.389	2.040	1.113	0.112	7.931	1.661
Communication services per resident	0.985	1.062	0.853	1.249	2.519	0.634
Exports per capita	0.965	0.970	0.332	2.359	3.971	0.029
Share of innovative enterprises	1.125	1.431	0.999	0.865	1.738	0.455
Share of employees at small enterprises	1.074	1.172	1.088	0.803	1.993	0.455

* Average indicator values for all Russia's constituent entities are taken per unit.
Source: calculated according to: Russian Regions. Socio-economic indicators. 2006–2016. Federal State Statistics Service. Available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1138623506156 (accessed:15.01.2018)

Figure 5. Characteristics of regional clusters from the standpoint
of three-component assessment of territories' socio-economic development
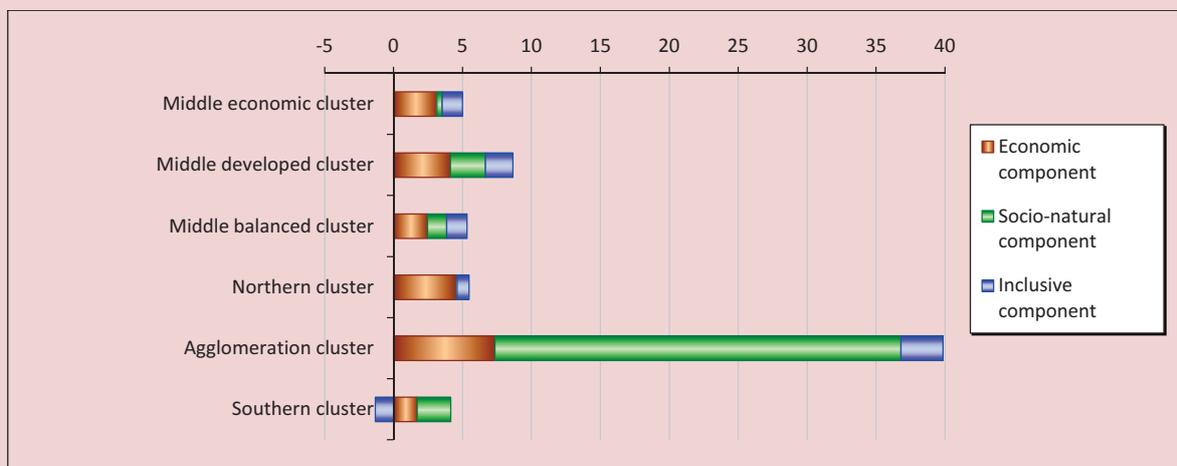
Source: compiled by the authors.

3. The backwardness of certain regions is most evident in the *inclusive component of development*. The low level of human-centered development of the Southern cluster territories is manifested in the fact that the indicators determining the quality of working life in these areas are much lower than the national average.

The revealed features of socio-economic development in the clusters have an impact on the population's economic behavior including the processes of reproductive increment of the quantitative component of human capital.

At the next stage of the study, the objective is to determine the responses of regional clusters

to changes in the institutional conditions of human capital reproduction. The regression analysis of reproductive increment coefficients of the quantitative component of human capital has helped obtain regression coefficients of the dummy variable (reflecting the introduction of the institution of maternity fund) by clusters, which are presented in *Table 3*.

The obtained values of standardized coefficients of the dummy variable by cluster put forward a hypothesis about the impact of the features of territory's development on the responses of regional systems with the introduction of the institution of maternal fund. To test this hypothesis, we studied the dependence of the standardized coefficient of the dummy variable on the level of socio-economic development of clusters, measured by a three-component vector (*Fig. 6*).

The results indicate that there is an inverse logarithmic correlation between the level of development and the impact of the institutional variable on the population's birth rate in clusters.

Table 3. Regression coefficients of the dummy (institutional) variable in the models of reproductive growth of the quantitative component of human capital in regional clusters

Regional cluster	Non-standardized coefficient	Standardized coefficient (β)
1. Middle cluster	1.253	0.276
1.1. Middle economic cluster	1.639	0.377
1.2. Middle developed cluster	1.078	0.264
1.3. Middle balanced cluster	0.928	0.253
2. Northern cluster	0.901	0.100
3. Agglomeration cluster	0.000	0.000
4. Southern cluster	6.445	0.487
Source: calculated according to: Russian Regions. Socio-economic indicators. 2006–2016. Federal State Statistics Service. Available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1138623506156 (accessed: 15.01.2018).		

Figure 6. Dependence of standardized regression coefficient of the institutional variable on the level of socio-economic development of regional clusters
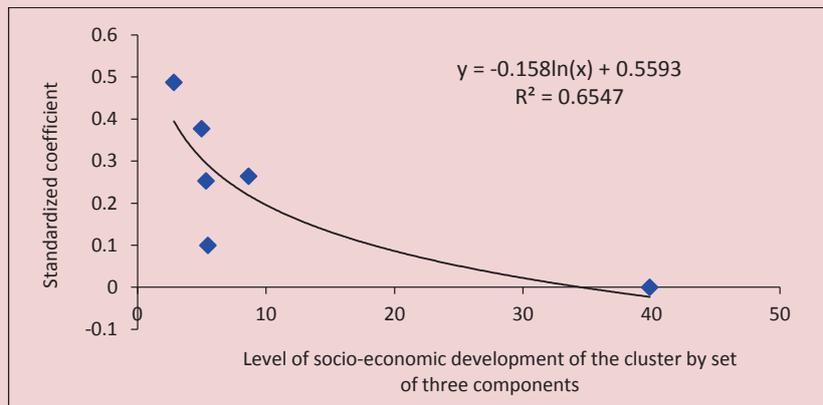
$y = -0.158\ln(x) + 0.5593$
$R^2 = 0.6547$

Source: calculated according to: Russian Regions. Socio-economic indicators. 2006–2016. Federal State Statistics Service. Available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog / doc_1138623506156 (accessed: 15.01.2018).

Moreover, we have studied the dependence of the nature of the regional clusters' response to changes in the institutional conditions of reproductive increment of human capital on each of the three components of the vector of territories' socio-economic development. The obtained second-degree polynomial dependence with a high degree of approximation accuracy indicates that the economic component has the strongest negative impact, as shown in *Figure 7*. The higher the level of economic development of cluster territories, which is reflected, in particular, in the level of real wages, new housing security for the population, the less is the influence of the institutional factor on the reproductive processes.

The level of socio-economic cluster development regarding the inclusive component, as well as the economic one, has a negative impact on the significance of institutional conditions for reproductive increment of the quantitative component of human capital, judging by the results presented in *Figure 8*. The less opportunities for the

population there are in the territory's labor market for entrepreneurial and innovative activities, the higher is the influence of the institution that performs the stimulating function to increase the birth rate.

The study of dependence of the dummy (institutional) variable on the socio-natural component that characterizes territories' sustainable development does not help draw definite conclusions due to high differentiation of clusters in terms of its level of development. Only if the Agglomeration cluster with abnormally high socio-natural component (mainly due to social development factors) is excluded from the set of objects under study can the power dependence of the degree of influence of the maternal fund institution on fertility depending on the quality of the socio-natural conditions in regional clusters be observed (*Fig. 9*). One of the most important indicators of this component is life expectancy at birth, which is a generalized characteristic of the environment in the regional space and climatic features of living in the territorial

Figure 7. Dependence of the standardized regression coefficient of the institutional variable on the economic component of the socio-economic development of regional clusters
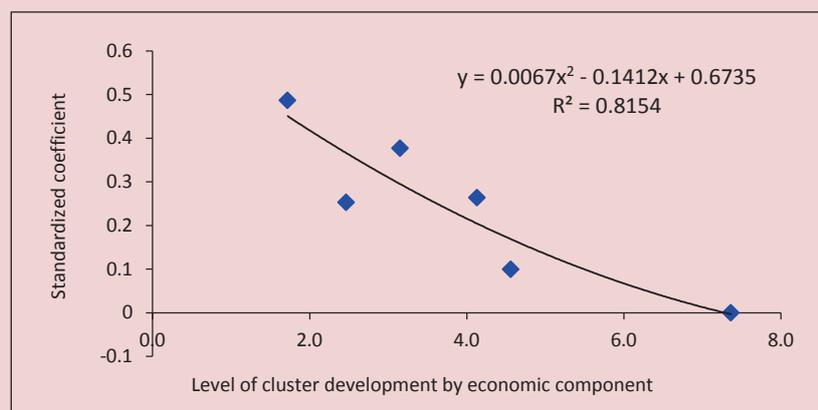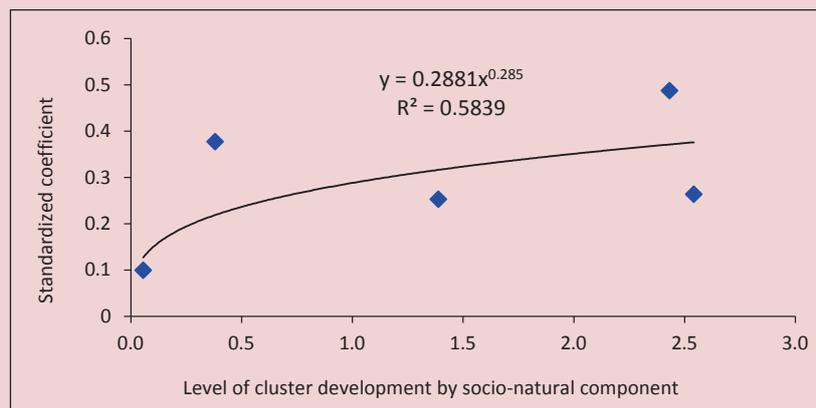
$$y = 0.0067x^2 - 0.1412x + 0.6735$$
$$R^2 = 0.8154$$

Source: calculated according to: Russian Regions. Socio-economic indicators. 2006–2016. Federal State Statistics Service. Available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1138623506156 (accessed: 15.01.2018).

Figure 8. Dependence of standardized regression coefficient of institutional variable on inclusive component of socio-economic development of regional clusters
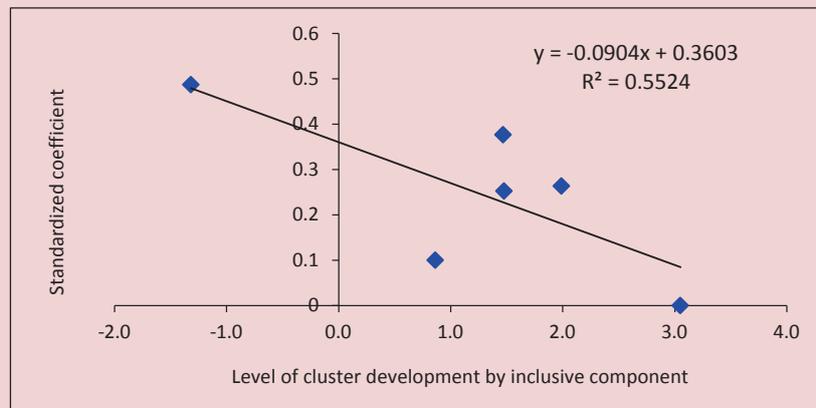
$$y = -0.0904x + 0.3603$$
$$R^2 = 0.5524$$

Source: calculated according to: Russian Regions. Socio-economic indicators. 2006–2016. Federal State Statistics Service. Available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/ doc_ 1138623506156 (accessed: 15.01.2018).

Figure 9. Dependence of standardized regression coefficient of institutional variable on socio-natural component of socio-economic development of regional clusters (excluding Agglomeration cluster)

$$y = 0.2881x^{0.285}$$
$$R^2 = 0.5839$$

Source: calculated according to: Russian Regions. Socio-economic indicators. 2006–2016. Federal State Statistics Service. Available at: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_ 1138623506156 (accessed: 15.01.2018).

zone. The more favorable these conditions are in the regional cluster, the greater is the institutional response of the socio-economic system to the introduction of the institution that stimulates the reproductive increment of the quantitative component of human capital.

The obtained dependences confirm the hypothesis of inverse dependence of the response reaction of territorial socio-economic systems to changes in the institutional conditions of the quantitative component of human capital on m the degree of economic and inclusive development of regional clusters. The motivational function of the maternity fund institution is reduced in the regions belonging to the type of clusters with high economic activity. This is particularly evident in the Agglomeration cluster.

Discussion and conclusion

Studying the responses of territorial socio-economic systems to changes in the institutional conditions of the reproductive increment of the quantitative component of human capital in Russian regions leads to the following conclusions.

1. The introduction of the institution of maternity fund was generally effective: in the ranking of impact of 13 studied indicator-factors characterizing the population's living conditions on the birth rate the institutional variable ranks second.

2. The living conditions and reproduction of human capital in the regional socio-economic systems in Russia have a significant differentiation both in the level of development and the degree of balance of components identified in the study (economic, social, and inclusive). These components have a multidirectional impact on the increment of the quantitative component of human capital. The responses of territorial socio-economic systems to changes in the institutional conditions under study decreases as the level of economic component increases and opportunities for successful work (inclusive component) in the regions are expanded. The stimulating function of the maternity fund institution is increasing in regional clusters with more favorable socio-natural living conditions.

Data obtained during the study help form an array of analytical materials on responses of regional socio-economic systems to changes in institutional conditions of the increment in the human capital quantitative component. They can be used to justify the forecasts of spatial development regarding the settlement system and development of strategies for the regions' socio-economic development, which will improve the "quality of government planning and regulation of regional economic development" [29].

3. The developed methodological approach can be used to study the influence of other institutions related to the regulation of population's economic behavior through the motivating function and aimed at the development of regional socio-economic systems in order to determine their comparative effectiveness.

Using the obtained results for management purposes will make it possible to implement the principles of the regional policy proclaimed in CSSD, which are *to improve the manageability* of spatial development, use *the differentiated approach* and *balance* the socio-economic space.

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