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METHOD TO ASSESS RESULTS OF STRATEGIC PROJECTS ON REGIONAL HUMAN CAPITAL DEVELOPMENT

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Abstract

Uncertainties, risks, and limited resources create a problem of optimum distribution of the available funds between strategic projects that influence the development of human capital in the region to maximize their results. The goal of this research is to develop a mathematical economic assessment method for the efficiency of strategic projects that directly or indirectly influence the development of human capital in a region in terms of their influence on the social and economic development. We suggest a model based on formalized influence channels. It is a two-level system of econometric dependencies. The first-level dependencies describe the influence of investment in regional human capital on the region's human capital development indicators. The second level reflects the influence of the regions' human capital development indicators on its social and economic development. The weighted change of the region's social and economic development indicators as a result of aggregate investment in a specific project over the set planning horizon was used as an efficiency criterion. The research is based on the statistics from official data sources. The produced database contains indicator values obtained in the regions of Russia over 2011-2018. We present an example of efficiency assessment for three identical strategic projects from two regions of Russia, the Primorsky territory and Belgorod Oblast. This example shows that the region's specifics have a significant influence on its social and economic development depending on the type of investment in the development of human capital.

Keywords: Social and economic development of a region, human capital of a region, regional project efficiency assessment, mathematical economic model

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1. Introduction

The development of any social and economic system is closely connected to the implementation of many different projects. Any large system has a great number of internal connections that are often counter-intuitive. Therefore, it can be difficult to assess the efficiency of project implementation due to the multiplier and synergistic effects. Any system operates with limited resources, which creates certain restrictions for project implementation. This requires the management to make efficient decisions taking into account the limited resources. All of the above makes the efficiency assessment problem for project implementation in complex systems relevant and requires the development of tools that would help perform a quantitative assessment of project implementation effects for the development of the system.

Nowadays, the academic community continues researching the problems of developing human capital at various levels. The research works can be split into three large groups.

The ones that deal with the assessment of human capital value. The work by (Gurban, 2015) interprets the value of human capital in a region as an average of five components. Others (Serebryakova et al., 2017) use a number of indicators to assess the value of human capital (labor productivity index, the share of knowledge-based industries in the GDP, etc). Many works deal with the quantitative assessment of human capital of specific territories like the USA (Christian, 2014), China (Li et al., 2016), etc.

The ones that deal with the impact of investment on human capital. The work by (Pelinescu, 2014) analyzes the impact of investing in the system of expert training, ensuring birth rates, and social welfare on the development of regional human capital. The research of (Percoco, 2016) deals with the impact of improving the quality of secondary and higher education in the country on the development of human capital. The work by Soubjaki (2017) analyzes the interconnections between the factors that have negative impacts on people's health and human capital. Others (Kaufmann & Wang, 2015) describe the interactions between human capital and regional development through the investment into healthcare and education.

The ones that assess the influence of human capital on the development of a specific social and economic system. Some works (McDonald, 2019) assess the influence of financial investment into human capital on the social and economic development of specific states and a country as a whole. Others (Zallé, 2019) speak about an inverse link between the development of human capital and the intensity of natural resource exploitation. The work by (Olopade et al., 2019) analyzes how human capital development impacts the reduction of poverty through long-term economic growth of the territory.

2. Problem Statement

The literature analysis shows that there is a lack of tools to determine the effects of implementing specific strategic actions for regional development and to establish an optimum selection of strategic regional projects that would impact the development of human capital in the region. The assessment of project implementation efficiency must take into account the current parameters and specifics of the regions, as well as the planning horizon.

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3. Research Questions

This research focuses on the social and economic development of a region from the viewpoint of its human capital. The subject matter of this research is the system of efficiency assessment for the implementation of strategic projects aimed at the social and economic development of the region.

4. Purpose of the Study

The goal of this research is to develop a mathematical economic assessment method for the efficiency of strategic projects that directly or indirectly influence the development of human capital in the region from the viewpoint of their influence on the social and economic development of the region.

5. Research Methods

The work by (Mazelis et al., 2018) suggests a conceptual model for the development of regional human capital based on influence channels: investment into the human capital of the region → region's human capital development indicators → the region's social and economic development indicators. In (Mazelis et al., 2018; Mazelis et al., 2020), there is a description of the influence channel formalization method as a two-level system of econometric dependencies.

Region's human capital investment is interpreted as aggregate financial resources spent on direct or indirect development of human capital. All human capital investments are split into 12 categories (r = 1, …, 12) as set out in (Mazelis et al., 2020).

Considering level 1 influence channels, human capital investment in the region impacts its development indicators. Human capital is assessed based on the values of 24 indicators (x1, …, x24) described in (Mazelis et al., 2020). However, to reduce the size and eliminate multicollinearity, we built main components for the human capital development indicators of a region (the method is described in (Mazelis et al, 2018). Before building econometric models, we divided regions into clusters according to their human capital indicator values (the method is described in (Mazelis et al., 2018)). Then we built econometric models for panel data of the clusters for the dependence between the key components of regional human capital indicators and investment:

$$RCX_k^n(t) = g_k\begin{pmatrix} RCX_k^n(t-1),\, z_1^n(t-1),\, ...,\, z_{12}^n(t-1), \\ z_1^n(t-2),\, ...,\, z_{12}^n(t-2),\, z_1^n(t-3),\, ...,\, z_{12}^n(t-3) \end{pmatrix}, \quad (1)$$

where $RCX_k^n(t)$ is the *k*-th key component of the human capital development indicators of region *n* at *t*; $z_{rn}(t-1)$ is the volume of human capital investment in region n for investment category *r* at *t; k* is the number of the key component, *k = 1, …, K;* n is the number of the region, *n* = 1, …, *N*.

Considering level 2 influence channels, the changes in human capital indicators for the region lead to the changes in its social and economic development indicators. The selection of social and economic development (w1, …, wP) is determined as described in (Mazelis et al., 2020). Then we built econometric models of panel data on the dependency between the indicators of social and economic development of a region and the key components for each of the clusters:

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$$w_p^n(t) = f_p\left(w_p^n(t-1), RCX_1^n(t-1), ..., RCX_K^n(t-1)\right), \quad (2)$$

where $w_p^n(t)$ is the value of social and economic development indicator p for region n at t; p is the number of a regional social and economic development indicator, $p = 1, \ldots, P$.

With the help of the constructed functions (1) and (2), we can use the direct counting method on recurrent dependencies to determine the impact of human capital investment in the region on the indicators of the region's social and economic development. To do this, we set up a matrix reflecting the changes of indicator p over T years as a result of category r financial investment as follows:

$$A^n(t_0+T) = \begin{pmatrix} \Delta_{11}^n(t_0+T) & \Delta_{12}^n(t_0+T) & ... & \Delta_{1P}^n(t_0+T) \\ \Delta_{21}^n(t_0+T) & \Delta_{22}^n(t_0+T) & ... & \Delta_{2P}^n(t_0+T) \\ ... & ... & ... & ... \\ \Delta_{R1}^n(t_0+T) & \Delta_{R2}^n(t_0+T) & ... & \Delta_{RP}^n(t_0+T) \end{pmatrix}, \quad (3)$$

where $\Delta_{rp}^n(t_0+T)$ is the change of the value of social and economic development indicator p for region n at (t_0+T) as a result of category r financial investment over the period of $[t_0; t_0+T]$, determined via this formula:

$$\Delta_{rp}^n(t_0+T) = \frac{w_{rp}^n(t_0+T) - w_p^n(t_0)}{w_p^n(t_0)}, \quad (4)$$

where $w_{rp}^n(t_0+T)$ is the value of social and economic development indicator p for region n at (t_0+T) as a result of category r financial investment over the period of $[t_0; t_0+T]$; and t_0 is the moment when planning starts.

We must note that there is a time gap between making the investment and obtaining results from it, which requires to account for the investment returns at some time lag. The length of the lag is determined when building econometric dependencies.

To assess the aggregated effect of human capital development investments for the region, we will use the following formula expressed as a matrix:

$$B^n(t) = E \cdot A^n(t) \cdot \Gamma^n, \quad (5)$$

where E is a single row-vector, $E = (1 \quad 1 \quad ... \quad 1)$; Γ^n is the column-vector comprising importance ratings for social and economic development indicator p of region n, and

$$\Gamma^n = \begin{pmatrix} \gamma_1^n \\ \gamma_2^n \\ ... \\ \gamma_P^n \end{pmatrix},$$ $0 \le \gamma_p^n \le 1$, $\sum_{p=1}^{P} \gamma_p^n = 1$, is determined by experts.

Thus, the efficiency assessment for the implementation of strategic projects on the social and economic development of the region is performed using the following model:

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$$\begin{cases} B^n(t) = E \cdot A^n(t) \cdot \Gamma^n, t = t_0 + 1, ..., t_0 + T, \\ A^n(t) = \begin{pmatrix} \Delta^n_{11}(t) & \Delta^n_{12}(t) & ... & \Delta^n_{1P}(t) \\ \Delta^n_{21}(t) & \Delta^n_{22}(t) & ... & \Delta^n_{2P}(t) \\ ... & ... & ... & ... \\ \Delta^n_{R1}(t) & \Delta^n_{R2}(t) & ... & \Delta^n_{RP}(t) \end{pmatrix}, \\ \Delta^n_{rp}(t) = \dfrac{w^n_{rp}(t) - w^n_p(t_0)}{w^n_p(t_0)}, \\ w^n_p(t) = f_p\left(w^n_p(t-1), RCX^n_1(t-1), ..., RCX^n_K(t-1)\right), \\ RCX^n_k(t-1) = g_k \begin{pmatrix} RCX^n_k(t-2), z^n_1(t-2), ..., z^n_{12}(t-2), \\ z^n_1(t-3), ..., z^n_{12}(t-3), \\ z^n_1(t-4), ..., z^n_{12}(t-4) \end{pmatrix}. \end{cases}$$

To assess the impact of aggregate human capital investment in the region on its social and economic development indicator *p*, we will use the following formula:

$$C^n_p(t) = E \cdot A^n(t) \cdot \begin{pmatrix} C^n_1 & C^n_2 & ... & C^n_p & ... & C^n_P \end{pmatrix}. \quad (6)$$

We must note that the row-vector comprises zero elements and only the required indicator number C^n_p is set to 1.

We can assess the impact of human capital investment category r on the region's social and economic development as follows:

$$D^n_r(t) = \begin{pmatrix} D^n_1 \\ D^n_2 \\ ... \\ D^n_r \\ ... \\ D^n_R \end{pmatrix} \cdot A^n(t) \cdot \Gamma^n. \quad (7)$$

We must note that the column-vector comprises zero elements and only the required indicator number D^n_r is set to 1.

We can use this model to assess the efficiency of both the regional investment program and each of the projects implemented on the regional level.

6. Findings

Consider the assessment of implementation effects of regional projects in the Primorsky territory and Belgorod Oblast. We will review three projects with identical parameters in all of the regions:

– the construction of a regional road: investment category – national economy; duration – 3 years; total costs – 4,000 million rubles;

– the construction of a bilingual school: investment category – education; duration – 3 years; total costs – 1,600 million rubles;

– the construction of an opera and ballet theater: investment category – culture, cinematography; duration – 3 years; total costs – 3,700 million rubles.

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Econometric models (1) and (2) that provide a functional description of the dependencies of the key components of regional human capital indicators on the investment and region's social and economic development indicators were built based on a panel database. The database contains the indicator values for the three categories in question: regional human capital, social and economic development of the region, and investments for the regions of Russia over 2011-2018. To improve the quality and adequacy of the models, they were built independently for each of the clusters described in (Mazelis et al., 2018) that comprise Russian regions depending on their human capital development levels.

We built groups of models of various types and with varying time lags and then selected the best ones using the Wald, Hausman, and Breusch-Pagan tests. The Primorsky territory and Belgorod Oblast belong to the 'small' and 'industrial' clusters respectively, and models with determined spatial effects proved to be the best for these clusters. Table 01 presents an example of functional relationship $RCX_1(t)$ for the Primorsky territory.

Table 1. $RCX_1(t)$ for the Primorsky territory

Indicator	RCX1			
	without t	t-1	t-2	t-3
Intercept	160 530 000			
RCX1		1 028 000 000		
z1		-0.058	-0.006	0.050
z2		1.891	-1.113	0.043
z3		0.057	0.0364	0.076
z4		0.004	-0.005	0.002
z5		0.004	-0.025	0.012
z6		-0.139	-0.142	0.018
z7		-0.010	0.004	0.012
z8		-0.020	-0.051	0.042
z9		0.017	0.019	-0.022
z10		0.000	-0.012	0.010
z11		-0.024	0.081	-0.040
z_{12}		0.183	-0.638	0.457

Assess the effects of project implementation for the social and economic development of the regions over 3 years using the model specified above. Table 02 presents a fragment of the result. We must note that the modified indicators of the region's social and economic development and their values were copied from the Law on Regional Budget.

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Table 2. A fragment of efficiency assessment for regional development project implementation

Region's social and economic development indicator	Region's social and economic development indicator change in %	
	Primorsky territory	Belgorod Oblast
The percentage of working population	0.2	0.1
The ratio between average per capita incomes and the minimum wage	1.0	0.2
Per capita monthly consumer expenses	1.4	0.3
The ratio between consumer expenses and the aggregate population income	0.1	0.0
Consumer price index as of December, compared to the last year's figures	0.0	0.0
…	…	…
Consolidated budget incomes of the region of Russia per capita	0.3	0.1
TOTAL	0.8	0.3

When analyzing Table 02 data, we can note that the implementation of the projects mentioned above can have significantly different effects for the Primorsky territory and Belgorod Oblast. For example:

– the main indicators for the Primorsky territory that will increase after the implementation of the projects include the agricultural production (mostly driven by the construction of the road) and the commissioning of residential and non-residential buildings (also largely driven by the road construction);

– the main indicator that will grow after project implementation in Belgorod Oblast is capital investment. We should point out that the development level of Belgorod Oblast stipulates significantly smaller returns on investments.

These differences can be explained by regional specifics reflected in the constructed functional relationships (1) and (2) and the fact that the initial indicator values for these regions were different.

7. Conclusion

We developed a method for the efficiency of projects that directly or indirectly influence the development of human capital in the region from the viewpoint of their influence on the social and economic development of the region. This method is based on functional dependencies (1) and (2) that describe the impact of investment into the region's social and economic development through the prism of human capital. The specific feature of this model is two-stage influence channel modeling: the structure and the amount of investment impacting the region's human capital development → the change in human capital indicators → the progress in achieving the goals and objectives of social and economic development.

We reviewed an example of a quantitative assessment of the effects of implementing three regional social and economic development projects in the Primorsky territory and Belgorod Oblast. The example shows that the implementation of these three identical projects has different impacts on the development of each of the regions. This signifies that the region's specifics and its current development level have a great influence on the project implementation effects.

This research has a practical significance that lies in the development of an applied tool to improve the efficiency of funding distributing when drawing up regional budgets with the help of the quantitative assessment of the project implementation effects for the social and economic development of the region.

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