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Childhood in Russian Regions: Simulation of Socio-Economic Processes

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***Abstract*—The aim of our study is to build models of socio-economic processes in the Russian regions, which are the background for the achievement of three indicators of the quality of childhood – health, education and spiritual and moral development. The parameters characterizing social and economic processes in the region are designated as managing factors, and indicators of quality of the childhood as target factors. The necessary empirical data are collected from the Russian statistical compilations, as well as the unified interdepartmental information and statistical system. 2016 was chosen as the observation period. The interaction of target and control factors is described by means of regression equations. Equations with the highest percentage of explained regression, as well as repetitive control factors (each target factor had its own equation) became the basis for the construction of the simulation model in AnyLogic. The approach of system dynamics has been chosen from among three approaches of stimulation, allowing to work with incomplete data, to track changes in the model over time, as well as to build cause-and-effect relationships between factors. In the system dynamics model, the target factors are overridden in 'drives', and the control factors – in variables (regulated and unregulated).**

Keywords—children; Russian regions; correlation and regression analysis; economic and infrastructure factors.

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1. INTRODUCTION

Childhood in the Russian regions has been influenced by economic and infrastructural factors. At the same time, different regions, due to the unique level of economic development, have a different impact on the key indicators of childhood: its health, education, spiritual and moral development [1].

The purpose of this study is to establish the cause-effect relationship between the economic and infrastructure elements of the system of regional indicators of childhood development and the construction of a simulation model.

The study of statistical data relating to socio-economic characteristics of the subjects of the Russian Federation allowed to form a set of 6 resulting (targeting) and 10 controlling factors affecting the situation of children in the region.

The quantitative scope of the 6 resulting and 10 controlling factors was carried out by referring to sources of statistical information. The 2015/2016 academic year was chosen for the analysis. The statistical data for the study were taken from the collections "Regions of Russia" [2], the unified interdepartmental statistical information system (EMISS), as well as the analytical information reports of regional data-processing centers (RCUs) and the regional centers for assessing quality of education (RCOCS).

The sampling is represented by 75 Russian regions, 10 subjects of the Russian Federation left out of consideration as a result of the lack of statistical data on individual factors.

A set of target factors includes:

Y1 -Proportion of children in the first group of health in total number of children under working age in the region,%; Y2 - Number of children with disabilities (0-17 years) who are monitored in outpatient clinics providing medical care to children; Y3 - Proportion of graduates who received certificates of secondary education,%; Y4 - Proportion of children who do not study in educational organizations to the number of children under working age in the region,%; Y5 - Coverage of children with additional education,%; Y6 - Ratio of the number of crimes of minors to the number of children under working age in the region,%.

The set of managing factors is presented: x1 -% of the population with incomes below the subsistence minimum,%; x2 - Proportion of households with a PC with Internet access,%; x3 - GRP per capita, thousands of rubles; x4 - Selling of strong alcoholic beverages (vodka and alcoholic beverages, cognacs, brandy), liter per capita; x5 - Sale of low-alcoholic beverages (with an ethyl alcohol content of not more than 9%), liters per person; x6 - Sale of beer, except for beer and malt liquor, liters per person; x7 - Total area of living quarters, average per individual inhabitant; x8 - Proportion of dilapidated and dangerous housing stock in the total area of the housing stock,%; x9 - Employment rate,%; x10 - Number of public buses per 100 thousand people; x11 - Density of public roads with a hard surface, km; x12 - Ratio of per capita incomes of the population to the subsistence minimum,%; x13- Share of urban population,%.

To determine the force of the influence of the control factors (x) on the targeting (Y), one of the previously mentioned groups of factors was taken [3] - the economic-infrastructure one.

In the first stage, the coefficient of Pearson's linear correlation was used to determine the relationship between the target factors and the control factors, and calculations were made using the analytical platform Deductor. Further, for each of the six targets, the following regression models were constructed (1-6):

$$Y_1 = -0.2748 + 2.065 * x_7 - 0.10986 * x_{12}; \quad (R^2 = 0.0914); \quad (1)$$

$$Y_2 = 1.154 + 0.00000276 * x_3 + 1.28 * x_5; \quad (R^2 = 0.18); \quad (2)$$

$$Y_3 = 81.54 - 0.195 * x_2 - 0.257 * x_8 + 0.4 * x_9 + 0.0713 * x_{13}; \quad (R^2 = 0.5693); \quad (3)$$

$$Y_4 = -0.286 + 0.006 * x_9; \quad (R^2 = 0.069); \quad (4)$$

$$Y_5 = 65.497 + 0.00000845 * x_3 - 0.0089 * x_{11}; \quad (R^2 = 0.107); \quad (5)$$

$$Y_6 = 0.122 - 0.00017 * x_{11} - 0.00051 * x_{12} + 0.00481 * x_{13}; \quad (R^2 = 0.441). \quad (6)$$

The values of R2 show a very low level of the explained regression, the highest value of R2 = 0.5693 is recorded in the case of an assessment of the impact of economic and infrastructural factors on the proportion of graduates who received a certificate of full secondary education in the 2015/2016 school year.

Analysis of the structure of regression equations reveals a different frequency of control factors entering them. The factors x3, x9, x11 and x12 appear twice. The factors x2, x5, x7, x8 appear 1 time.

For the simulation, the regression equations Y1, Y3 and Y6 were selected, because on the one hand, they characterize such components of the quality of childhood in the regions as children's health, education and spiritual and moral development. And, on the other hand, in the equations Y1, Y3 and Y6, in aggregate, the greatest number of control factors is involved, which will allow to track the influence of a larger number of agents on the indicators of childhood in the regions. It must be noted that the actions of federal and regional authorities are aimed at increasing the values of indicators Y1 and Y3 and reducing the values of Y6. The signs of the coefficients of the control factors demonstrate a different direction of their influence on the target factors.

The transition to simulation modeling, the control (Y) and target factors (x) present in the regression equations were described in terms of system dynamics, recoded into storage devices, dynamic variables and parameters [2]. The data obtained are presented in Table 1.

TABLE 1. ELEMENTS OF THE MODEL "SOCIO-ECONOMIC FACTORS OF CHILDHOOD IN THE REGIONS" AND THE INITIAL VALUES FOR THE EXPERIMENTS

Factor	**Designation in the model, model element, unit of measur**	**Default value**	**Value Range**
Proportion of children in the first group of health in total number of children under working age in the region	Health groups, Dynamic variable, %	Determined by the formula 1	0 - 100
Proportion of graduates who received certificates of secondary education	Share_of_graduates, Dynamic variable, %	Determined by the formula 3	0 - 100
Ratio of the number of crimes of minors to the number of children under working age in the region	Crimes_of_minors, Dynamic varia, %	Determined by the formula 6	0 – 100
Proportion of households with a PC with Internet access	PC_Innernet, Parameter, adjustable value, %	71.103	59 – 100
Total area of living quarters, average per individual inhabitant	living_area Parameter, adjustable value, m^2	24.87	13.5 – 33.4
Proportion of dilapidated and dangerous housing stock in the total area of the housing stock	dilapidated_housing, Parameter, adjustable value, %	3.33	0 – 18
Employment rate	Employment Constant, %	64.17	49-75
Density of public roads with a hard surface	Road density Parameter, adjustable value, %	289.97	2.9 - 2453
Average per capita income of the population	Income of people Parameter, adjustable value, roubles	27 152.77	14 216 – 66 869
Living wage in the Russian Federation	Subsistence Parameter, adjustable value, roubles	9759.49	7 775 – 18 427
Ratio of per capita income of the population to the subsistence level	X12 Dynamic variable, %	278.219	0 -860
Share of urban population	urban_pop, Parameter, adjustable value, %	70.889	40.4 - 100
Proportion of children in the first group of health in total number of children under working age in the region	Health groups, Dynamic variable, %	Determined by the formula 1	0 - 100
Proportion of graduates who received certificates of secondary education	Share_of_graduates, Dynamic variable, %	Determined by the formula 3	0 - 100
Ratio of the number of crimes of minors to the number of children under working age in the region	Crimes_of_minors, Dynamic varia, %	Determined by the formula 6	0 – 100

In addition to the elements indicated in Table 1, the constant model "A", the coefficients of influence, the adjustable parameters will be included in the final model. The initial value of the adjustable parameters and dynamic variables is set by default as the average of the data for 75 regions (at the end of the 2015/16 academic year).

A fragment of the constructed simulation model is provided in Figure 1. It is necessary to note that this scheme is generalized and required further specification. To build the model, the software product AnyLogic (© The AnyLogic Company) was used.

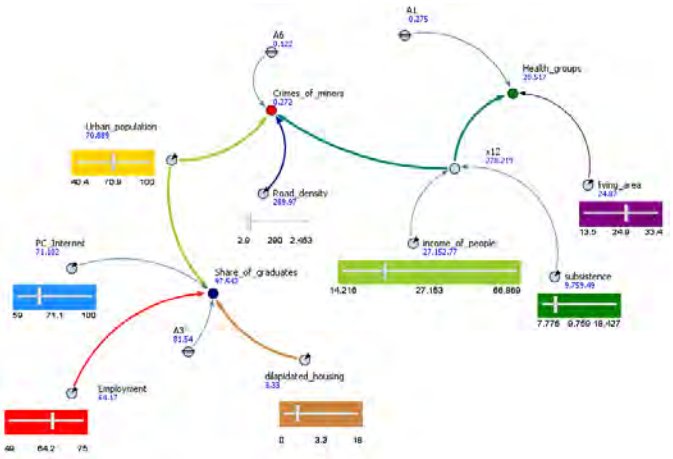

Fig.1. Fragment of the system dynamics model "Influence of economic-infrastructure group factors on childhood in the regions"

All the control factors presented in the simulation model will be conditionally divided into two groups: those that are subject to regional regulation (x2, x7, x8, x11, x12) and are difficult to regulate regionally (x9, x13). Control elements "runners" were attached to parameters, allowing to change the initial values and conduct experiments. When the model starts, if desired, one or several parameters can be changed, so without special tools, it is possible to conduct deterministic factor analysis by the method of chain substitution or to analyze the sensitivity of models.

Table 2 shows the results of three experiments with the values of Y1, Y3 and Y6. In the first case, the stability and accuracy of the model are checked, for this value of the variables is set as the average annual results of the 2015/16 school year.

Experiment 1 showed high modeling accuracy, the maximum relative deviation of the data obtained in the course of the experiment 1 from the actual results of the 2015/16 school year was 0.467%.

In the second experiment, the values of the initial adjustable parameters (x2, x7, x8, x11 and x12) were increased by 10%. In the course of experiment 2, it was found that the increase in Y1 was negatively affected by an increase in the average per capita income of the population from 27 152 to 29 867 rubles. If the difference between income and the subsistence minimum remained at the level of the average Russian level, then the increase in the share of children in the first group of health would be 25.031%.

TABLE 2. RESULTS OF THREE EXPERIMENTS WITH THE SIMULATION MODEL

Index	Y1 Proportion of children in the first group of health in total number of children under working age in the region	Y3 Proportion of graduates who received certificates of secondary education,%;	Y6 Ratio of the number of crimes of minors to the number of children under working age in the region,%.
Actual average	20.5515	97.5264	0.273
Results experiment 1	20.5517	97.542	0.272
Results experiment 2	22.597	96.069	0.253
Results experiment 3	22.597	97.627	0.253
Absolute deviation	-0.0343	0.015	0.001
Relative deviation	-0.167 %	0.015 %	-0.366 %

The data of Experiment 2 also show that if the housing conditions of families deteriorate and the other influences have a positive effect simultaneously, a decrease in the proportion of graduates of schools that have received certificates is inevitable.

The increase in the indicators x11 and x12 by 10% favorably affected the decrease in the number of crimes of minors and allowed to reduce Y6 by 7.033%.

The third experiment is related to a selective change in the values of the control factors that affect Y3. To increase the proportion of graduates with certificates, we fix x2 at the average informatization level of 71.103%, but at the same time we will reduce the share of dilapidated and emergency housing stock in the total area of the entire housing stock from 3.33 to 2.993%. All other initial values of the control factors are left at the level of the values of experiment 2.

As a result of the third experiment, it was possible to increase the indicator Y3, characterizing the level of education, by 0.088%. At the same time, only one social and economic factor had to be changed-x8, reflecting proportion of dilapidated and emergency housing.

Therefore, the constructed simulation model represents a fragment of evaluation and management of indicators of social and economic development of childhood in the regions based on the analysis of the most significant demographic, institutional and economic-infrastructure factors. The model allows to imitate the process of managing regional resources and mitigating regional risks through the introduction of relevant regional indicators as an input data.

References

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