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NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
12	0	0

BUSINESS PERSPECTIVES

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SIMULATIVE MODEL FOR EVALUATION OF INVESTMENT PROCESSES IN THE REGIONS OF UKRAINE

Abstract

To analyze and evaluate the investment processes in the regions of Ukraine, it is suggested to use a simulative model that, unlike existing ones, allows to take into account the influence of macroeconomic factors and to predict the future development of the economic system of the regions taking into account their investment potential. The examination of the assessed simulative models of the investment processes in the regions of Ukraine for adequacy is carried out using the determination coefficient and Fisher's criterion, by which the influence of the most significant economic variables of social and economic development of the regions on the investments formation is determined. Research of the investments impact on the dynamics of economic systems indicators of the regions has shown that 86% of the constructed models are adequate. The presence of statistically significant estimates of model parameters confirms the effectiveness of the proposed approach for conducting research on the analysis and forecasting of the patterns of significant indicators formation of investment activity at the regional level, as well as their impact on indicators of social and economic development.

Keywords	investment, region, estimation, simulative modeling, model
JEL Classification	R10, R15, R58, E17

INTRODUCTION

The current trends in the social and economic and investment situation of the regional systems require to justify a model of regional investment processes in order to identify possible expectations and effects, as well as to form an effective policy for economic and investment development. Complex research of the investment processes and general economic trends in the context of the regional economy is actualized in the process of raising the social and economic status of the regions, since certain territorial units are characterized by certain peculiarities (geographic, economic, demographic, social, etc.) and the implementation of the relevant programs and strategies for regional development.

1. ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

Investment analysis is crucial for the success of any investment, as this process is facilitated both by the analysis of discounted cash flows and by the real analysis of options. Many researchers point out the restrictions for the first of them in cases of volatility in the business environment. Kinias, Tsakalos, and Konstantopoulos (2017) tried to find the optimal investment strategy in the liberalized world of electricity

market, where electricity prices fluctuate, while other factors differ in each country. The authors consider time factors for investments and the level of prices for electricity, using the theory of real variants.

Researching the problems of evaluation of direct foreign investment, net exports and economic growth by the example of the Republic of Kazakhstan, Azatbek and Ramazanov (2016), based on the method of calculating the expenditure of gross domestic product (GDP) and using the method of regression analysis, determined the impact of foreign direct investment (FDI) and net exports on GDP and the interaction of FDI and net exports as components of GDP.

Ābeltiņa, Zvirgzdiņa, and Ozols (2016) emphasize the importance of distinguishing the endogenous factors in the regional development of Latvia, in particular the most important factors influencing on regional development, the authors consider the decision of the government and the existing infrastructure, as well as the influence of migration, distance from the center and availability of investments. These findings regarding regional development are applied, in particular, to a small country where the geographically and historically single, highly developed economic and political centers has developed.

In the research of the current state of investment in fixed assets and the justification of the ways of state regulation in attracting investment into the regions of Ukraine, Stepanenko (2013) states that the assessment and forecasting of the investment attractiveness of the regions of Ukraine should be directly related to the state regional policy, the purpose of which is to ensure the development of individual regions, taking into account such factors as the rational use of the various economic opportunities of each of Ukraine's regions.

Johnston Robert A. and Caroline J. Rodier (1998), investigating the various problems associated with regional modeling of ITC, have identified the economic welfare model by adapting it to previous projects.

Research of the problems of regional investment policy modeling is partly highlighted in the works

of Kononsky (2014) who indicates that it is the adequate definition of the methods of modeling regional investment policy that enables to develop an objective and effective model as a modern state of the regional investment policy, as well as a planned, transitional one. At the same time, the author suggests the use of all modern modeling methods, since this will allow us to obtain the most informative understanding of the current state and prospects of regional investment policy development. In our opinion, this approach is sufficiently complex, but difficult to implement, since a certain economic space of the region is characterized by appropriate social and economic trends, which necessitates the search for adequate modeling methods.

Gudz (2013), in the research of theoretical aspects of the economic and mathematical modeling of the investment potential of a region, offers to determine the investment potential of a region with the help of economic and mathematical modeling, the construction of economic and mathematical model to implement it using progressive mathematical and statistical methods, most suitable for the analysis, evaluation and forecasting of investment the potential of the regions.

The estimation of the econometric model of symmetric equations for formalizing the interconnections between the main indicators of the monetary and fiscal sectors was studied by Dadashova (2014), while the author determines econometric model in the form of a system of symmetric equations as a prerequisite for opportunity of its estimation.

Investigating the impact of macroeconomic indicators of partner countries on the aggregated behavior of their households (on the example of the Russian Federation and Ukraine), Zdrok (2013) proposed a simulative model that can study and predict the behavior of households and methods of influencing it at the international level.

During creating a complex econometric model of the impact of tax policy on the country's economic development, Salo (2015) assessed the structure of the relationship between the main macroeconomic indicators and indicators of the Consolidated Budget of Ukraine, their future proposed development in different scenarios.

Irshak (2013) highlighted the main stages in the formation of a simulative model of the banking system of Ukraine: formation of the logical framework of a model (determination of interrelations between the variable of a model) and the model specification, estimation of unknown parameters of the simulative model with the help of developed estimation methods, in particular, the two-step method of smallest squares, as well as verification of the adequacy and accuracy of the constructed model, development of scenarios for the development of the banking sector on the basis of the constructed model taking into account the dynamics of the environment.

Emphasizing the general aspects of simulative modeling, Lychkina (2009) notes that methodologically the creation of new concepts for the formalization and structuring of models that are oriented on mathematical and information systems, support for the entire simulation cycle: from task set up and creation, conceptual model before the analysis of the results of the calculated experiment and decision-making, mathematical use of statistical methods, mathematical methods, optimization and decision making. Simulation modeling, which enables to form a generalized model of the system based on separate data and to study the dynamics of the development of social systems, is the main method of system forming in regional tasks of social and economic development.

Tikoudis, Sundberg, Karlström (2012) in their research developed an issue concerning simulative modeling on the example of modeling of two-spatial OLG of transport infrastructure, with the increase of state investments and the reduction of freight costs for two regions, which, respectively, is noted on lower regional price indices.

Thus, in the study of conceptual foundations of the basis for simulation modeling of macro- and microeconomic processes, evaluation of the interconnections between macro or microeconomic indicators, the authors primarily focused on national tendencies and policies (tax, fiscal, monetary), while scientific research is rather fragmentary in coverage of instrumental support at the regional level, which remains undeveloped and characterized by certain features and trends in the investment providing dimension.

2. THE AIM OF THE RESEARCH

The aim of the research is to evaluate the investment processes and regularities of the regions of Ukraine with the use of simulator model tools, which, accordingly, makes it possible to study the influence of factors of the social and economic development of the regions on the formation of investments and the investments impact on the dynamics of indicators of economic systems of the studied regions (industrial production, number of employees, exports, etc.).

3. MAIN RESULTS OF THE RESEARCH

A complex algorithm for assessing the investment attractiveness of the regions of Ukraine is based on the following consecutive steps that are outlined in the study of the Institute of Regional Studies of the National Academy of Sciences of Ukraine: 1) the determination of the actual level (or normalized values) of each of the output indicators for which evaluation of the investment attractiveness of a region is carried out; 2) forecasting the level of each of the standardized indexes for the next year under consideration, taking into account the dynamics of the actual values of these indices for the selected period; 3) construction of the regions ratings of the studied totality by the level of their investment attractiveness for each of the averaged actual and for each of the predicted values of normalized indices; 4) construction of regions rating for each of the selected 7 criteria of investment attractiveness (or group ratings); 5) construction of general (or integral) regions ratings based on the calculation of integral indicators on the base of the total values of the group (actual and forecast) indicators of investment attractiveness, determined at the previous (4th) stage of evaluation; 6) construction of a complex (or summary) region ranking based on complex indicators determined by combining the corresponding integral indicators of investment attractiveness; 7) the distribution of regions to the relevant groups by the level (actual and predictable) of the indicators of their investment attractiveness. In our opinion, the assessment of investment processes in the regions should be based not only on the analysis of investment at-

tractiveness, but also in the consideration of interdependencies with social and economic trends, in particular, the dynamics of the gross regional product, volumes of sold industrial products by main types of activity, export value, etc.

In order to analyze the investment processes in the regions of Ukraine (selected Western regions: Lviv, Ternopil, Transcarpathian, Chernivtsi and Ivano-Frankivsk regions), as well as to assess of the nature of the impact of investment activity indicators on the parameters of social and economic development of regions based on the statistical information (formed on the basis of the State Statistics Committee of Ukraine), we used samples from the following indicators: $KINV_t$ – the value of capital investments, billion UAH; $FINV_t$ – the amount of direct foreign investment, million USD; GDP_t – gross regional product at actual prices, billion UAH; $PROM_t$ – volumes of sold industrial products (works, services) by main types of activity, billion UAH; EMP_t – the number of the employed population of working age, thousand of persons; EX_t – export value, million USD; BUD_t – volume of executed construction works, billion UAH; TOV_t – retail turnover, billion UAH; REV_t – the amount of income of the population, billion UAH.

It should be noted that there are significant territorial imbalances in the social and economic development of these regions and investment processes in particular: the growth of $KINV_t$ in the Lviv region amounts to 9.646 billion UAH in 2010 to 18.605 billion UAH in 2016; Ivano-Frankivsk region – 4.378 billion UAH in 2010 to 7.947 billion UAH in 2016; Ternopil region – 2.138 billion UAH in 2010 to 4.888 billion UAH in 2016; Transcarpathian region – 2.205 billion UAH in 2010 to 4.63 billion UAH in 2016; Chernivtsi region – 1.714 billion UAH in 2010 to 2.668 billion UAH in 2016.

At the same time, the gross regional product at actual prices $\left(GDP_t\right)$ was as follows: in the Lviv region, 41.655 billion UAH in 2010 up to 94.690 billion UAH in 2015; Ivano-Frankivsk region – 20.446 billion UAH in 2010 to 45.854 billion UAH in 2015; Ternopil region – 12.276 billion UAH in 2010 to 26.656 billion UAH in 2015; Transcarpathian region – 15.299 billion UAH in 2010 to 28.952 billion UAH in 2015; Chernivtsi region – 9.892 billion UAH in 2010 to 18.506 billion UAH in 2015.

Paying attention to the complicated nature of the relationship between the main indicators of investment activity and the indicators of social and economic development of the regions studied for analysis in the framework of our research, we have chosen the toolkit for simulative modeling. The simulative investment models in the studied regions allow to investigate the influence of factors of the social and economic development of the region on the formation of investments and the impact of investments on the dynamics of indicators of economic systems of the studied regions (industrial production, number of employees, exports, etc.).

The simulative models of the investment sphere contain 2 blocks: investment formation and investment use. The first block of models makes it possible to investigate the factors that influence on the formation of capital and direct foreign investment in the regions, and contains two equations. The second block of simulative models in the investment sphere consists of five equations and allows to investigate the influence of the amount of capital and direct foreign investments in the studied regions on the dynamics of the main macroeconomic indicators (gross regional product, production of industrial products, etc.).

By the results of the system analysis of the processes of formation of investment development indicators, and the impact of these indicators on the parameters of social and economic development of the regions, we have identified a list of endogenous and exogenous variables. To solve the problem of forming a set of priority indicators that determine the regularities of changing the values of both investment activity parameters and indicators of social and economic development, matrices from the coefficients of pair correlation between the studied indicators were formed for each region. The ranking of the values of the pair correlation coefficients for the analyzed indicators for each region, as well as the application of the method of step-by-step regression analysis to select the factors that are the priority in terms of forming the investment component of social and economic development and its regulation, allowed to form the following models:

Ivano-Frankivsk region

$$KINV_t = f\left(FINV_t,\ TOV_t,\ \varepsilon_t\right)$$

$$FINV_t = f\left(KINV_t,\ \varepsilon_t\right)$$

$$GDP_t = f\left(TOV_t,\ \varepsilon_t\right)$$

$$PROM_t = f\left(GDP_t,\ \varepsilon_t\right)$$

$$EMP_t = f\left(GDP_t,\ BUD_t,\ \varepsilon_t\right)$$

$$EX_t = f\left(FINV_t,\ KINV_t,\ \varepsilon_t\right)$$

$$TOV_t = f\left(GDP_t,\ REV_t,\ \varepsilon_t\right)$$

Ternopil region

$$KINV_t = f\left(REV_t,\ FINV_t,\ \varepsilon_t\right)$$

$$FINV_t = f\left(KINV_t,\ \varepsilon_t\right)$$

$$GDP_t = f\left(TOV_t,\ PROM_t,\ \varepsilon_t\right)$$

$$PROM_t = f\left(GDP_t,\ TOV_t,\ REV_t,\ \varepsilon_t\right)$$

$$EMP_t = f\left(KINV_t,\ \varepsilon_t\right)$$

$$EX_t = f\left(REV_t,\ \varepsilon_t\right)$$

$$TOV_t = f\left(GDP_t,\ PROM_t,\ \varepsilon_t\right)$$

Lviv region

$$KINV_t = f\left(REV_t,\ TOV_t,\ \varepsilon_t\right)$$

$$FINV_t = f\left(GDP_t,\ REV_t,\ \varepsilon_t\right)$$

$$GDP_t = f\left(TOV_t,\ PROM_t,\ \varepsilon_t\right)$$

$$PROM_t = f\left(GDP_t,\ \varepsilon_t\right)$$

$$EMP_t = f\left(REV_t,\ \varepsilon_t\right)$$

$$EX_t = f\left(REV_t,\ \varepsilon_t\right)$$

$$TOV_t = f\left(REV_t,\ GDP_t,\ \varepsilon_t\right)$$

Chernivtsi region

$$KINV_t = f\left(REV_t,\ \varepsilon_t\right)$$

$$FINV_t = f\left(EMP_t,\ PROM_t,\ \varepsilon_t\right)$$

$$GDP_t = f\left(TOV_t,\ REV_t,\ \varepsilon_t\right)$$

$$PROM_t = f\left(REV_t,\ \varepsilon_t\right)$$

$$EMP_t = f\left(BUD_t,\ FINV_t,\ \varepsilon_t\right)$$

$$EX_t = f\left(EMP_t,\ \varepsilon_t\right)$$

$$TOV_t = f\left(GDP_t,\ \varepsilon_t\right)$$

Transcarpathian region

$$KINV_t = f\left(FINV_t,\ REV_t,\ \varepsilon_t\right)$$

$$FINV_t = f\left(KINV_t,\ EMP_t,\ \varepsilon_t\right)$$

$$GDP_t = f\left(TOV_t,\ \varepsilon_t\right)$$

$$PROM_t = f\left(REV_t,\ \varepsilon_t\right)$$

$$EMP_t = f\left(FINV_t,\ \varepsilon_t\right)$$

$$EX_t = f\left(FINV_t,\ \varepsilon_t\right)$$

$$TOV_t = f\left(GDP_t,\ \varepsilon_t\right)$$

Let us fulfill the following conventions: y_1 – the amount of capital investments, billion UAH; y_2 – amount of direct foreign investment, million USD; y_3 – gross regional product in actual prices, billion UAH; y_4 – volumes of sold industrial products (works, services) by main types of activity, billion UAH; y_5 – the number of the employed population of working age, thousand people; y_6 – export value, million USD; y_7 – turnover of retail trade, billion UAH; x_1 – the amount of population income, billion UAH; x_2 – volume of executed construction works, billion UAH.

The estimation of parameters of simulative models is carried out by means of a number of methods, in particular methods of two-stage and three-

stage least squares, the method of maximum likelihood with limited or complete information, the method of instrumental variables etc. The verification of the generated models in terms of rank and order has showed that the equations of models for all regions are identified or converted, which makes it possible to use a two-stage least squares for finding of their estimation (Two-Stage Least Squares, TSNLS), which is implemented in the SPSS (Statistical Package for Social Search) environment. The idea of the two-stage least squares method is to replace stochastic endogenous variables (which correlate with factor characteristics) by instrumental (auxiliary) variables, which are mostly calculated as a linear combination of non-stochastic exogenous variables.

As a result of the two-stage least squares method application, the following evaluated models were obtained:

for the Ivano-Frankivsk region:

$$y_1 = 10.108 + 0.211y_2 - 0.022y_5, \ R^2 = 0.802$$

$$y_2 = 268.458 + 71.458y_1, \ R^2 = 0.91$$

$$y_3 = -256.971 + 0.572y_5, \ R^2 = 0.808$$

$$y_4 = 0.353 + 0.733y_3, \ R^2 = 0.899$$

$$y_5 = 456.075 + 20.692x_2 + 0.898y_3, \ R^2 = 0.838$$

$$y_6 = 1598.009 + 123.83y_1 - 2.566y_2, \ R^2 = 0.755$$

$$y_7 = 0.854 - 0.192x_1 + 2.514y_3, \ R^2 = 0.988$$

for the Lviv region:

$$y_1 = -0.359 + 0.255x_1 - 0.174y_7, \ R^2 = 0.617$$

$$y_2 = 152.051 + 3.166x_1 - 4.628y_3, \ R^2 = 0.801$$

$$y_3 = 6.099 + 0.761y_4 + 0.745y_7, \ R^2 = 0.986$$

$$y_4 = -1.233 + 0.604y_3, \ R^2 = 0.968$$

$$y_5 = 991.448 + 10.529x_2, \ R^2 = 0.507$$

$$y_6 = 1152.755 + 26.112x_2, \ R^2 = 0.647$$

$$y_7 = -5.368 + 3.738x_2 + 0.547y_3, \ R^2 = 0.987$$

for the Transcarpathian region:

$$y_1 = 2.609 + 6.146x_1 - 0.006y_2, \ R^2 = 0.798$$

$$y_2 = -606.577 - 27.859y_1 + 2.138y_5, \ R^2 = 0.598$$

$$y_3 = 4.338 + 0.198y_7, \ R^2 = 0.965$$

$$y_4 = -3.117 + 31.413x_1, \ R^2 = 0.596$$

$$y_5 = 458.276 + 0.103y_2, \ R^2 = 0.339$$

$$y_6 = 741.621 + 1.456y_2, \ R^2 = 0.509$$

$$y_7 = -18.008 + 4.845y_3, \ R^2 = 0.965$$

for the Ternopil region:

$$y_1 = 3.285 + 0.103x_1 - 0.048y_2, \ R^2 = 0.952$$

$$y_2 = 80.314 - 6.062y_1, \ R^2 = 0.779$$

$$y_3 = -2.059 - 0.441y_4 + 0.463y_7, \ R^2 = 0.992$$

$$y_4 = -5.955 + 0.426x_1 + 0.201y_3, \ R^2 = 0.957$$

$$y_5 = 382.266 + 3.555y_1, \ R^2 = 0.434$$

$$y_6 = 99.633 + 6.333x_1, \ R^2 = 0.742$$

$$y_7 = 5.92 + 1.939y_3 + 1.254y_4, \ R^2 = 0.996$$

for the Chernivtsi region:

$$y_1 = 0.586 + 0.069x_1, \ R^2 = 0.672$$

$$y_2 = -269.327 - 2.691y_4 + 1.067y_5, \ R^2 = 0.756$$

$$y_3 = 0.358 + 0.583x_1 + 0.338y_1, \ R^2 = 0.954$$

$$y_4 = -3.46 + 0.376x_1, \ R^2 = 0.926$$

$$y_5 = 276.868 + 27.67x_2 + 0.389y_2, \ R^2 = 0.792$$

$$y_6 = -172.155 + 0.899y_5, \ R^2 = 0.683$$

$$y_7 = -5.361 + 4.483y_3, \ R^2 = 0.971$$

Verification of the estimated models for adequacy by means of the determination coefficient and Fischer's criterion has shown that 86% of the constructed models are adequate. The presence of statistically significant estimates of model parameters (as shown by the analysis, such as from 55 to 78% of assess-ments depending on the region) confirms the effectiveness of the proposed approach for conducting a research on the analysis and forecasting of the patterns of formation of key indicators of investment activity at the regional level, as well as their impact on indicators of social and economic development.

CONCLUSION

The analysis of investment processes in the regions of Ukraine by means of simulative modeling in the study between the magnitude of capital investments and social and economic indicators has made it possible to determine the priority directions of investment policy of a region and the development of their social and economic environment. The presented research of the current state of investment processes in the regions by means of simulative modeling allowed to determine the structure of interconnections between the magnitude of capital investments and social and economic indicators of a region, which also made it possible to study the influence of factors on the formation of investments and the impact of investments on the indicators of regions development. It should be noted that there is a significant disproportionate and uneven territorial distribution of the magnitude of capital investment and direct foreign investment, which has a corresponding effect on the formation of the gross regional product, volumes of sold industrial products (works, services) by major types of activity, export value, retail turnover, volume of executed construction works, and also forms the basis of regional employment of the population and the size of their income.

Thus, the formation of the investment attractiveness of the Western regions of Ukraine and the increase of investment activity, which in aggregate contributes to the improvement of the indicators of the social and economic situation of the regions, first of all should be based on the use of significant potential of recreational resources, advanced level of international scientific cooperation, system of diversification of services, active use of innovative technologies in various sectors of the economic space of the regions, etc.

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