Multifactor Correlation-Registration Analysis for Modeling the Regional Social and Economic System in the Informational Adviser System

A V Averchenkov1, E E Averchenkova1, A A Martynenko1

1Bryansk State Technical University, Bryansk region, Bryansk 241035, Russia

E-mail: mahar@mail.ru

Abstract. The current state of modeling regional socio-economic systems cannot yet be defined as an effective tool for developing regional policy in the Russian Federation. The article presents an algorithm for modeling a regional socio-economic system for the needs of the developed information advising system. The authors have carried out an algorithm that substantiates the expediency of applying a specific mathematical function to describe trends in increasing indicators for forecasting the socio-economic development of the Russian Federation region in the devised information advising system. The article presents the experience of using multiple regression to simulate the values of the sample indicator of developing the regional socio-economic system “Investments in fixed capital” on the example of the Bryansk region. As the initial data, the departmental expenditure structure of the Bryansk region is used for the departments of economic growth, construction and architecture for 2011-2019. The regression equations are formed, and then the model is evaluated for reliability, and the results of the regression analysis for the estimated indicator are given. The article makes the conclusion that using multifactorial correlation and regression analysis to simulate a regional socio-economic system on the data of the Bryansk region will expand the capabilities of the developed information advising system.

1. Introduction

This article is a continuation of a number of works [1-6], devoted to the features of developing information advising system (IAS), which allows exercising managerial influence based on the results of modeling the region socio-economic development. The Bryansk region is used as a reference region in the IAS.

Scientific forecasting as a basis for planning the socio-economic development of regions is actively developed in the works of such domestic and foreign authors as N.T. Agafonova, N.A. Aitova, B.I. Bursa, M.M. Butakova, Yu.N. Gladky, A.G. Granberg, M.S. Guseva, D. Jones, J. Dietrich, T.A. Dubrova, R.P. Istomina, A.M. Kovalevsky, Yu.A. Kryuchkova, O.S. Sukharev, A.A. Fedorchenko, A.P. Chernikov G.E. Shepitko, A.A. Shirov, B.M. Stulberg, etc. [7-9]. The experience of foreign authors is interesting in supporting the adoption of management decisions in regional governments. Such authors are S. Al-Jaghoub, H. Al-Yaseen, M. Al-Hourani, C. Bertolissi, M. Fernandez, M.E. Elhdhili, L.B. Azzouz, F. Kamoun, P.T. Jaeger, J.C, Bertot, S. Kallel, A. Charfi, M. Mezini, M. Jmaiel, A. Sewe, I.H. Osaman, A.L. Anouze, Z. Irani, H. Lee, A. Balcī, T.D. Medeni, V. Weerakkody, X. Papadomichelaki, G. Mentzas, A.J. Sahoo, R.K. Tiwari [10-17].
1.1. Relevance of the article
Despite a significant amount of research in the field of forecasting regional socio-economic development [18-21], studies remain relevant to forming complex techniques, including those based on modern mathematical methods. The obtained results of forecasting will be put into the knowledge base of the IAS and will become the basis for the subsequent formation of a managerial decision complex allowing people to improve the management quality at different levels of regional authority.

1.2. Task setting
Thus, the knowledge base developed by the authors of the IAS presents a list of the fixed indicators of forecasting the region socio-economic development assigned to the executive bodies of the state power or structural divisions of the regional government [22,23]. These data will allow carrying out mathematical modeling, and then creating a new list of indicators that require management decisions. A list of modeled indicators of forecasting the region socio-economic development is formed. To do this, the IAS refers to the knowledge base and, using a specific algorithm, selects the most significant indicators for further correlation and regression analysis. The resulting mathematical models are evaluated for suitability [23].

2. Theoretical part

2.1. Algorithm for modeling a regional socio-economic system in the information advising system
Earlier [1–6], it was shown that modeling the region socio-economic development was primarily characterized by the complexity of taking into account influencing factors. Also in [24], the experience of forming mathematical dependencies describing the most significant trends in the socio-economic development of the Bryansk region was given. Fig. 1 presents the corresponding algorithm, which substantiates the expediency of applying a specific mathematical function to describe trends in developing forecast indicators for the socio-economic development of the Russian Federation region in the developed IAS.

So, the user of the IAS can choose specific indicators assigned to the executive bodies of the state power or structural divisions of the regional government, which will be modeled by the means of the IAS. Further, the algorithm envisages the possibility of using single- or multifactor regression for forming mathematical dependence. Thus, when an indicator of forecasting the region socio-economic development is assigned to the knowledge base of an information system, only one executive body of the state authority will use a single-factor correlation and regression analysis. If the indicator of forecasting the region socio-economic development is assigned to several executive bodies of state power, then the IAS ensures the algorithm implementation for the branch that ultimately forms the multifactorial model.

As a result, for each indicator assigned to the executive bodies of the state power or structural divisions of the regional government, the IAS forms an estimate of the indicator values for the near future. Using the principle of materiality described in earlier papers [25], the program forms recommendations on the need for managerial influence on the analyzed indicators [1-6].

3. Practical Significance

3.1. Experience of using multiple regression for modeling a sample indicator of developing the regional socio-economic system (on the example of the Bryansk region)
On the basis of the algorithm presented in Figure 1, the authors modeled one of the indicators of the socio-economic development of the Bryansk region – “Investments in fixed assets”.

The departmental expenditure structure of the Bryansk region budget for 2012-2019 was used as independent data (x1 and x2) for building the regression model [1]. Earlier, the authors of articles [2, 3] showed that the departmental structure of budget expenditures determined the amount and direction of funding in various departments of the Bryansk region, i.e. in the priority areas of the region for its socio-economic development. This distribution of budget allocations is stipulated by the budget law of
the Bryansk region. The values of the simulated indicator (Y) for 2012-2019 were taken from the “List of key indicators submitted to develop a forecast of the socio-economic development of the Russian Federation in the Bryansk region”.

Figure 1. The flowchart of the simulation algorithm of the regional socio-economic system in the information advising system.
Since the indicator “Investments in fixed capital” is influenced by several factors (budget financing in two departments), therefore, it is necessary to build a multiple regression model. To search for the best regression model the authors use the method of stepwise variable selection. When choosing the types of transformations, based on the allowable values for variables, preference is given to polynomials of the first, second and third degrees. The model of investment dependence in fixed assets from the budget of the Bryansk region departments is:

\[ Y = 73661 + 27.4x_1^3 - 85.91x_2^2 + \varepsilon \] (1)

The resulting regression model describes 87% of the data considered. This figure is very high. Also, the constructed model satisfies the Fisher criterion (F-criterion) and its significance level. Thus, the hypothesis of existing a linear dependence of investments in fixed assets on independent parameters is rejected.

4. Conclusion
The use of multifactor correlation-regression analysis for modeling a regional socio-economic system based on the data from the Bryansk region will expand the capabilities of the developed information advising system. It should be noted that in the model under consideration, only 8 observations were used (according to the number of estimated time periods), therefore, when analyzing the constructed regression model, the graphical method of analysis was mainly applied. The basis for further research is the possibility of using statistical methods in forming a large sample of the analyzed data, where their application will be complementary.

References
[1] Averchenkov A V, Averchenkova E E, Goncharov D I 2017 Modeling the socio-economic development of the Bryansk region for information advising system Bulletin of BSTU (Bryansk: FSBEI HE "BSTU") pp 137-143
[2] Averchenkova E E, Averchenkov A V 2016 Information monitoring of regional socio-economic systems Bulletin of BSTU (Bryansk: FSBEI HE "BSTU") pp 177
[3] Averchenkova E E, Averchenkov A V, Goncharov D I 2017 Mathematical modeling of regional development indicators in a conceptual model for assessing the impact of the external environment on the regional socio-economic system Proceedings of VSUIT T 79 2 (Voronezh, VSUIT) pp 290-295
[4] Averchenkova E E, Goncharov D I 2017 Applying materiality threshold for indicators of forecasting the socio-economic development of the Bryansk region when making management decisions at the regional level Economics in the context of social and technological development of the world [Text] + [Electronic resource]: proceedings of the II International interdisciplinary scientific conference on fundamental and applied problems of modern socio-economic and economic-ecological development (Bryansk: FSBEI HE "BSTU") pp 205-211
[5] Averchenkova E E, Averchenkov A V, Kulagina N A 2017 Designing of the Information Advising System to Assess the Potential of Creation and Development of Cluster Agglomeration in the Industrial Complex of the Region International Conference on Information Technologies in Business and Industry 2016 IOP Conf. Series: Journal of Physics: Conf. Series 803 012011 doi:10.1088/1742-6596/803/1/012011 p 012011
[6] Averchenkov A V, Averchenkova E E, Gorlenko O A, Miroshnikov V V 2017 Machine-building Enterprise Fuzzy Model as the Interrelated Factor Complex System International Conference on Information Technologies in Business and Industry 2016 IOP Conf. Series: Journal of Physics: Conf. Series 803 012009 doi:10.1088/1742-6596/803/1/012009 p 012009
[7] Sukharev O S 2017 Some modern problems of regional development Current Trends in Regional Development: Proceedings of the III Intern. scientific-practical conf. pp 32-51
[8] Sukharev O S 2015 Regional Economic Policy: Structural Approach and Instruments (Theoretical Statement) Economy of the region (Moscow: AMZ) pp 370-385
[9] Fedorchenko A A 2012 The value of effective monitoring of socio-economic development of regions Terra Economicus (Rostov-on-Don: Southern Federal University) pp 93-99
[10] Chernikov A P 2013 Making management decisions under uncertainty Proceedings of Irkutsk State Economic Academy (Tomsk: Tomsk State University) pp 51-59
[11] Al-Jaghoub S, Al-Yaseen H, Al-Hourani M 2010 Evaluation of Awareness and Acceptability of Using E-Government Services in Developing Countries: The Case of Jordan Electronic Journal of Information Systems Evaluation 13 pp 1-8
[12] Bertolissi C, Fernandez M 2009 Distributed event-based access control Int. J. of Information and Computer Security vol 3 3/4 pp 306-320
[13] Elhedhili M E, Azzouz L B and Kamoun F 2009 Reputation Based Clustering Algorithm For Security Management In Ad Hoc Networks With Liars Int. J. of Information and Computer Security vol 3 3/4 pp 228-244
[14] Jaeger P T, Bertot J C 2010 Designing, Implementing, and Evaluating User-Centered and Citizen-Centered E-Government International Journal of Electronic Government Research 6 2 17 (USA) pp 105-122
[15] Kallel S, Charfi A, Mezini M, Jmaiel M, Sewe A 2009 A holistic approach for access control policies: from formal specification to aspect-based enforcement Int. J. of Information and Computer Security vol 3 3/4 pp 337-354
[16] Osaman I H, Anouze A L, Irani Z, Lee H, Balcă C, Medeni T D, Weerakkody V 2011 A New COBRA's Framework to Evaluate E-Government Services: A Citizen Centric Perspective Paper presented at iGov Workshop (London: iGOV11) pp 243-256
[17] Papadomichelaki X, Mentzas G 2012 E-GovQual: A Multiple-Item Scale for Assessing E-Government Service Quality Government Information Quarterly 29 1 (UK) pp 98-109
[18] Sahoo A J, Tiwari R K 2016 A novel approach for hiding secret data in program files Int. J. of Information and Computer Security vol 8 1 pp 1-10
[19] Averchenkov V, Kazakov P, Kazakov V, Reutov A, Lozbinev F 2015 Application of evolutionary algorithm to multiobjective optimization of hydraulic actuation system In the collection Proceedings of 2015 International Conference on Mechanical Engineering, Automation and Control Systems (Tomsk: MEACS) p 7414856
[20] Lozbinev F Y, Gamov A A, Spasennikov V V 2016 Modeling of Element Reliability of a Corporate Telecommunications Network in the Territory of the Russian Federation 2nd International Conference on Industrial Engineering, Applications and Manufacturing (ICIEAM) (Chelyabinsk: South Ural State University) pp 85-86
[21] Kulagina N A, Lozbinev F Yu, Kobischanov V V, Ivkina N N 2017 Regional features of functioning of the geoinformation analytical system of innovative potential International Conference on Information Technologies in Business and Industry IOP Publishing. IOP Conf. Series: Journal of Physics: Conf. Series 803 012084. doi:10.1088/1742-6596/803/1/012084 p 012084
[22] Averchenkov A V, Averchenkov V I, Kazakov Y M, Leonov E A, Leonov Y A 2014 Architecture and Self-learning Concept of Knowledge-Based Systems by Use Monitoring of Internet Network Knowledge-Based Software Engineering. Communications in Computer and Information Science (New York: Springer International Publishing) pp 15-26
[23] Averchenkova E E, Pomogaeva K Yu 2017 Features of forming and distributing the budget of the Bryansk region in 2016 Problems of Cultural Heritage Preservation: Proceedings of the VI International Seminar (December 2, 2016) Branch of the ANPEO in “MPSU” in Bryansk (Bryansk: LLC “New Project”) pp 165-171
[24] Averchenkov V, Roschin S, Ryтов M, Averchenkov A and Kamaev V 2015 Conceptual Model of Monitoring Information on the Internet. International Journal of Soft Computing 10(3) (Pakistan: World Agri. Database) pp 220-225
[25] Averchenkov A, Budylskii D, Podvesovskii A, Ryтов M, Yakimov A 2015 Hierarchical Deep Learning: A Promising Technique for Opinion Monitoring and Sentiment Analysis in Russian-
Language Social Networks *Creativity in Intelligent Technologies and Data Science: First Conference, CIT&DS 2015* (Volgograd, Russia) pp 583-592

[26] Averchenkov A V, Averchenkov V I, Kolyakin V V, Orekhov O D 2016 Issues of a computer-aided design of hydraulic jacks *IOP Conference Series: Materials Science and Engineering* p 012040