Application of Econometric Methods and Neural Network Analysis in Regional Sustainable Development Management Programs

Luisiena E. Puinko[a] and Elena V. Tolkacheva[b]
Far-East Institute of management, branch of the Russian Presidential Academy of National Economy and Public Administration (hereinafter RANEPA), Khabarovsk, Russia

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Abstract: The digitalization of the economy in Russia is subject to management influence from Federal, regional, and municipal Executive authorities. At the same time, there is a continuous search for methods and tools to improve its effectiveness. This process is complicated, among other things, by the fact that trends at all levels of economic digitalization management and mechanisms for its implementation in Russia currently remain insufficiently studied. The use of classical statistical and econometric methods for assessing and predicting socio-economic processes, both in Russia as a whole, and in individual regions and municipalities on its territory, has proven itself well; and at the same time, they are very time-consuming, and the result obtained through the use of statistical or econometric methods of analysis is obtained with a certain time delay; and at the time of its receipt, it does not correspond to the stated goals of the study. Then econometric analysis and statistical methods should be replaced by a tool that will allow you to get results faster with no less quality, and use it in a timely manner when implementing and correcting management tasks. One of the directions of development of new tools for analyzing many processes of dynamics, stochastic processes, and systems with big data is artificial intelligence, or information systems based on it. In the conditions of incomplete information about the socio-economic processes of any region, statistical methods of assessment can even give an erroneous result, which can provoke fatal management errors. To minimize forecasting estimates and optimize analysis and evaluation procedures, it is necessary to rely on modern, new and effective methods for analyzing stochastic processes.

1 INTRODUCTION

The regional system is a complex mechanism for the functioning of objects and their relationships. The development of any socio-economic system (regional and industry level) is a process of interaction of trends and patterns arising from the characteristics of this system, which is internally contradictory and dynamic (Decree Of the government of the Russian Federation No. 313, 2014). The study of regional socio-economic systems is complicated by at least two fundamental difficulties. First, socio-economic systems are complex systems that depend on a very large number of variables (Decree of the President of the Russian Federation No. 204, 2018). And, secondly, the behavior of such systems is difficult to formalize and predict (Federal state statistics service, 2019).

1.1 The Basic Methods in the System of Regional Management

In General, it should be noted that regional analysis methods are understood as a set of tools for analyzing the location and development of regional systems. Among the main methods for regional studies are highlighted in the comparative-geographical method, the method of synthesis and analysis and iterative method, method of economic and mathematical modeling, the balance method, program and target method, mapping method, index method, methods of sociological research method, the zoning method of development potential, the method priorities

[a] https://orcid.org/0000-0002-8938-130X
[b] https://orcid.org/0000-0003-1304-809X

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(Zubarev, 2017; Zhadan, 2018; Sudarushkina and Stefanova, 2017; Chernova, 2019; Shvab, 2016; Digital economy-national projects-Khabarovsk territory, 2020; Official portal "Ministry of digital development, communications and mass communications of the Russian Federation", 2020).

1.2 Assessment of Individual Indicators of Socio-economic Development in the Digital Economy Contour

In terms of the use of information and communication technologies, in General, the regions of the far Eastern Federal district reach the national average, while the remoteness of the far Eastern Federal district from the Western regions of Russia plays an important role. on the one hand, the use of the Internet and home computers in households reaches an average of 70%, while online purchases make up 28.6%, which is associated with the delivery of these goods to remote areas (i.e., a poorly developed logistics network for delivering online purchases to the population) (Federal state statistics service, 2019). The use of public services on the Digital government portal reaches 47% in the far Eastern Federal district, which, according to the authors, is due to insufficient coverage of public services that can be obtained by the population in electronic form, and MFC exist and do not work in all hard-to-reach areas of the far Eastern Federal district (or their work is not profitable) (Decree Of the government of the Russian Federation No. 313, 2014; Decree of the President of the Russian Federation No. 204, 2018).

2 PROBLEM STATEMENT

The authors of the study analyze individual socio-economic processes related to the development of the digital economy in the region. We tried to evaluate individual indicators of socio-economic development using classical methods of econometric analysis, and also selected various models to implement data analysis as accurately as possible. For the purpose of the study, the further use of the obtained results of the found model for forecasting and adjusting management programs was laid. However, there was a complication that the time spent by researchers to search for and evaluate the results of the selected model was large. The time interval for obtaining a ready-made assessment and the possibility of using it to adjust socio-economic development measures overlapped with the time for calculating and selecting the desired model. At the time of receiving the results of the assessment of socio-economic development processes in the region in the digital economy contour, these results were already outdated. The authors tried to determine whether classical methods of econometric analysis are suitable for assessing complex systems of socio-economic development in the region in modern conditions. At the same time, I would like to emphasize that econometric methods and models have proven themselves well for analyzing and evaluating relatively simple dependencies: when considering the relationship of several factors that affect the result, there are not many endogenous and exogenous variables in the model; each individual factor included in the model does not represent a complex system of interaction of additional variables. However, socio-economic processes in the region are always a multi-factor complex system, in which individual variables, both endogenous and exogenous, can be revealed, again, as a complex system. For example, the standard of living of the population depends on nominal accrued wages, expenditure patterns of households, unemployment rate, availability of medical care, structure, household income, housing affordability, crime rates in the region, etc., each listed variable of influence is a complex system dependent on many other factors, and are interrelated. Formal work is like unemployment rate and crime rates (crime rate and unemployment rate are directly proportional), the same processes affect training of the population, the possibility of retraining, the level of culture, family values etc.

Any econometric analysis involves the processing of statistical information previously collected either through official (state) services, such as regional divisions of Rosstat, or through specialized representative surveys, which involve the involvement of both state and non-state funds and institutions of socio-economic analysis (Federal state statistics service, 2019).

At the same time, the econometric models themselves are divided into spatial models and temporal models (trend analysis models). Spatial models assume an assessment of socio-economic processes at a given time. Time series-construction of the development trend of the socio-economic process under study for a number of consecutive moments in time. Both in the first and in the second case the forecast values can be calculated quite successfully based on the found model; in both cases, the sample of data used to build an econometric model should not only be representative of the quality of the collected statistical data, but also in terms of volume: less than

thirty observations are usually not used for qualitative econometric analysis. For a qualitative analysis of time series, the sample size must be a multiple of. Many socio-economic processes are stochastic, which complicates the choice of tools for analysis (Federal state statistics service, 2019; Piunko, 2019).

2.1 Regional Management of Socio-economic Processes as a Form of Spatial Analysis Models

Regional management of certain socio-economic processes is a rather complex system, which from the position of econometric analysis can be theoretically justified either by a system of econometric equations (according to the authors), or by a time trend. In our opinion, it is not correct to apply the multiple regression model here, since regional management is not a single factor under study, but a set (complex) of management factors in various sectors of the economy and the social sphere. Thus, you can design "regional management" as a model of the form $\hat{y} = f(x1; x2; x3; x4;...; xn)$, where xn are individual socio-economic indicators, does not seem to be correct for research (the multiple regression model is not applicable here, it can only be applied to individual processes in management).

In our opinion, multiple regression and correlation can only be applied to certain socio-economic processes, such as: the convenience of registering a child in a preschool educational institution, including through electronic public services, the convenience of providing tax reporting, including through network communication channels, individual indicators of electronic interdepartmental interaction, the availability of medical services, including using electronic public services, etc.

2.2 Analysis of Socio-Economic Processes in the Region through Systems of Econometric Equations

Systems of econometric equations assume a preliminary knowledge-intensive econometric analysis, the purpose of which is to select independent factors in the system, which are then built up in the system and distributed in its equations.

At the same time, the selected factors themselves cannot correlate with each other, and there should be no duplicate factors in the system. After constructing a model system of econometric equations describing state regulation, it is necessary to determine the condition of identifiability for it, and then calculate the parameters of this system.

Such a study is very time-consuming, and given the current dynamics of regional management processes, we assume that a theoretically constructed model of a system of econometric equations describing regional management as a system of interrelated factors (the most significant at the beginning of the study), at the time of evaluating its quality and calculating forecast values (i.e., at the final phase of the study) – will give an outdated result, which will be somewhat distorted forecast values. In other words, the laws of statistical analysis, which compare the summary characteristics of aggregates of objects and phenomena related to the life of society in different periods of time, also work here.

2.3 Methods of Time Series Analysis for Forecasting Socio-economic Processes in the Region

Time series analysis, primarily the study of economic processes through VAR models, which is a special case of a system consisting of simultaneous equations, analysis through ARMA and ARIMA models, analysis of socio-economic processes as difference-stationary series (DS-series, Difference Stationary) or autoregressive fractional integrated moving average model (autoregressive fractionally integrated moving average – ARFIMA, which involve collecting a very large number of observations from 800 or more), the use of autoregressive models with distributed lags (ADL models) - as a kind of dynamic models, also involves collecting a large range of data under study. Bayesian time series models, which involve hierarchical modeling and are used when information is available at several different levels of observable quantities, are convenient for hierarchical analysis, and in some cases for multidimensional analysis; but in the context of research on public management of socio-economic processes, including the digitalization of the economy, it is not convenient and takes a lot of time to build them (first of all, a large range of initial statistics - data collection for analysis).

Analysis of sales data indicators for the digital economy; was chosen a model with fixed effects analysis of panel data, model selection was due to the goal setting criteria of the target values of the national project "Digital economy", and, as well, the statistical data for analysis.

3 RESEARCH QUESTIONS

The study was supported by the far Eastern Institute of management, a branch of the Russian state Academy of national economy and public administration under the President of the Russian Federation and the government of the Khabarovsk territory. The research was carried out using neural network analysis of individual indicators of digital economy development in the region, assessment of measures related to the management of socio-economic processes. As part of the study, a survey of experts was conducted in the number of 45 people who are representatives of business entities, regional authorities, the scientific community, and public organizations. During the survey, the task was set: to determine the conceptual validity of the created neural network models, taking into account the expected impact of digitalization of the economy on the organizational and administrative activities of government bodies.

3.1 The Importance of using Neural Network Analysis in Management as the Main Hypothesis of the Study

In formulating the questions the expert survey was based on the hypothesis that representatives of business entities, regional authorities, scientific and educational community, and public organizations interested in the framework of their professional or educational activities, as well as the implementation of functions of public control in obtaining reliable analytical information about the organizational and managerial activities of the regional authorities on digital economy development in Khabarovsk Region.

3.2 Evaluation of an Expert Survey on the Use of Neural Network Analysis in Management

When deciding about the implementation of neural network analysis for analyzing management and administrative activities of regional authorities in Khabarovsk region on the development of the digital economy must consider the lack of digital competence of all potential categories of users: researchers, faculty, staff, business representatives, representatives of public organizations (Federal state statistics service, 2019).

4 PURPOSE OF THE STUDY

The aim of the work was to provide theoretical justification and develop a method for neural network analysis of methods of regional management of digitalization of the Khabarovsk territory economy, as well as recommendations for its practical application.

Currently, a number of management measures have been taken in the Khabarovsk territory to achieve digital integration of communications in public administration, in the provision of state and municipal services, as well as to create a modern information environment in the production of goods and services. At the same time, a number of issues arise that directly affect the assessment of possible socio-economic risks of making certain management decisions at the regional level. The results of this study will expand the theoretical understanding of the methods of regional management of digitalization of the economy in the Khabarovsk territory, as well as test the methodology for studying the results of regional management based on artificial intelligence.

5 RESEARCH METHODS

For the purposes of this study, the most interesting were the normative and index methods. The normative method is a method of substantiating indicators of socio-economic development of the region using pre-developed and legally established norms and standards. Norms and regulations represent the necessary base, scientific development of regional economic forecasts, plans, programs, technical and economic projects. As for the index method, it is most often used to quantify the level of specialization of socio-economic zoning. In this case, the base year indicator is taken as a basis and the growth or growth rates of indicators are calculated, which should collectively show statistically significant phenomena. These methods were used in the analysis of individual indicators of the development of the digital economy of the Khabarovsk territory.

6 FINDINGS

In the current dynamics of socio-economic development, there is a need to use other approaches to collecting and processing statistical data based on modern intelligent information technologies. They

allow, firstly, to collect and process data faster, secondly, their use is cheaper than traditional methods, and thirdly, the result of these studies in terms of validity and reliability will be higher than in traditional studies.

6.1 The Inappropriateness of the Use of Econometric Analysis in Forecasting Complex Systems of Socio-Economic Governance

Regional management in the field of digitalization of the economy also involves consideration of the management function as a system of management factors in the digitalization of services to the population, digitalization of interdepartmental interaction, development of state information systems, replacement of imported software with similar domestic production (especially in the public sector), digitalization and development of regional market platforms, digital monitoring of individual socio-economic processes (including improving monitoring of public procurement through appropriate on-line platforms), calculating transaction costs, etc.

If the task for the researcher is just to evaluate a separate control factor, or its separate process, then multiple regression models or systems of econometric equations can be considered as a fairly reliable and convenient research tool.

Due to attempts to apply econometric analysis in practice (primarily time series analysis) of individual socio-economic processes; difficulties in finding reference statistical data to include in the model under study; difficulties with calculating the model parameters, and most importantly, evaluating the quality of the found model, which in terms of indicators was not always suitable for further forecasts and did not correctly assess the effects obtained from certain management processes (public administration activities to achieve the stated goals), it was concluded that it is necessary to use other tools in terms of evaluating and analyzing management processes. Moreover, we considered tools and models that could independently correct system errors within themselves. Econometric and statistical analysis had to be abandoned due to the above disadvantages. Analysis of sales data indicators for the digital economy; was chosen a model with fixed effects analysis of panel data, model selection was due to the goal setting criteria of the target values of the national project "Digital economy", and, as well, the statistical data for analysis (Official portal "Ministry of digital development, communications and mass communications of the Russian Federation", 2020).

Also, based on the results of sociological surveys, they often build an econometric model of the studied factor or group of socio-economic factors, getting some error in the analytical model. Given that the socio-economic processes taking place in the regions of Russia are usually complex and multi-factorial, the construction of econometric models for them is often impractical.

6.2 Possibilities of using Information Systems for Statistical Data Analysis in Management Models

It should also be noted that modern domestic developments of information technologies and information systems provide partial automation of operations in the state management of socio-economic processes. They allow processing statistical data on various socio-economic indicators, are progressive, and flexible in integration. Also, information technologies significantly reduce the time of specialists in performing statistical and economic analysis tasks. The development of domestic software, modern information systems and technologies are particularly in demand today, as they are tools for integrating the entire state management system at all levels into the digital economy.

6.3 Difficulties in using Neural Network Technologies in the Analysis of Public Administration in the Khabarovsk Territory

When deciding about the implementation of neural network analysis for analyzing management and administrative activities of regional authorities in Khabarovsk region on the development of the digital economy must be considered insufficient digital competences of all potential categories of users: researchers, faculty, staff, business representatives, representatives of public organizations. At the same time, you can also take into account the importance of using domestic software, which leads to two ways: using a package of applications for statistical data analysis with a built-in machine learning add-on, or ordering software from a developer.

At the same time, the software being developed must be able to perform statistical data analysis in addition to machine learning capabilities.

6.4 The Main Content of the Expert Survey on the Use of Neural Network Analysis in Management

Experts were asked to evaluate the statements that characterize the features of using neural networks to analyze the regional management of digitalization of the Khabarovsk territory economy. In particular, the assessment was based on the following indicators:

- The need to use neural networks in analyzing the development of the digital economy in the Khabarovsk territory;
- Sufficiency of application of statistical methods in the analysis of the activities of regional authorities of the Khabarovsk territory;
- Difficulties in using neural networks in regional authorities due to the lack of understanding of the features of applying the neural network analysis methodology by employees;
- The importance of using domestic software in conducting neural network analysis of the activities of the Khabarovsk territory authorities for the development of the digital economy;
- The potential of neural networks for operational adjustment of the activities of regional authorities for the development of the digital economy in the Khabarovsk territory.

In formulating the questions the expert survey was based on the hypothesis that representatives of business entities, regional authorities, scientific and educational community, and public organizations interested in the framework of their professional or educational activities, as well as the implementation of functions of public control in obtaining reliable analytical information about the organizational and managerial activities of the regional authorities on digital economy development in Khabarovsk Region.

6.5 Results of an Expert Survey on the Use of Neural Network Analysis in Management

Based on the responses received, we identified five groups of experts, and the following results of the expert survey were obtained.

The largest group of experts supports the introduction of neural network analysis to analyze the activities of regional authorities for the development of the digital economy using domestic software.

The second group of experts indicates the importance of using neural network analysis of government activities in conjunction with statistical methods of analysis.

The third group of experts supports the introduction of neural network analysis to analyze the activities of regional authorities in the development of the digital economy, but at the same time emphasizes the non-necessity of using domestic software.

There is also a group of experts who do not support the use of neural network analysis of government activities, focusing on the use of statistical methods.

And you can select a group of neutral experts.

In General, it can be noted that 63.5% of experts support the need to use neural networks to analyze the activities of regional authorities, having a difference of views only in the tools for its implementation.

So 56% of experts noted that to analyze the development of the digital economy in the Khabarovsk territory, it is necessary to use neural networks that can build complex predictive models.

52% of experts note that it is also necessary to continue using statistical methods for analyzing the activities of regional authorities.

48% of experts noted that the use of neural networks by employees of regional authorities of the Khabarovsk territory is currently difficult due to insufficient knowledge of the neural network analysis methodology.

At the same time, 52% noted that neural networks will help quickly adjust the activities of regional authorities for the development of the digital economy in the Khabarovsk territory.

Thus, when deciding about the implementation of neural network analysis for analyzing management and administrative activities of regional authorities in Khabarovsk region on the development of the digital economy must be considered insufficient digital competences of all potential categories of users: researchers, faculty, staff, business representatives, representatives of public organizations.

7 CONCLUSION

Thus, in this study, a theoretical model of administrative and administrative methods of regional management of digitalization of the economy in the Khabarovsk territory was developed. Information models of neural networks used for analyzing administrative and administrative activities of regional authorities of the Khabarovsk territory also received their justification. Based on the calculation of validity errors, their verification is

evaluated. The main hypothesis of the study is that the use of neural network models will eliminate the lack of knowledge about the possible socio-economic consequences of the use of various administrative and administrative methods of regional management of the digitalization of the economy in the Khabarovsk territory; in the course of the study, the hypothesis was confirmed.

This applied research allowed us to clarify the existing knowledge about the possibilities of using neural network models to analyze the results of regional management of economic digitalization, including in the Khabarovsk territory.

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REFERENCES

Decree Of the government of the Russian Federation No. 313 of 15.04.2014 "On approval of the state program" Information society (2011-2020)"». (2014). https://digital.gov.ru/ru/documents/4137/.

Decree of the President of the Russian Federation of 07.05.2018 No. 204 "On state goals and strategic objectives of the development of the Russian Federation for the period up to 2024" (2018). URL: http://www.kremlin.ru/acts/bank/43027/page/1.

Federal state statistics service: information on the socio-economic situation in Russia, January-August 2019. URL: https://rosstat.gov.ru/storage/mediabank/oper-08-2019.pdf .

Federal state statistics service: information on the socio-economic situation in Russia, January-August 2019. https://gks.ru/storage/mediabank/oper-08-2019.pdf .

Piunko, L.E. (2019).Directions of development of digital economy and information society in Russia. *1st International Scientific Conference on Modern Management Trends and the Digital Economy - From Regional Development to Global Economic Growth (MTDE)* -Yekaterinburg, RUSSIA, volume 81 pages 150-153. https://www.atlantis-press.com/proceedings/mtde-19/125908808.

Zhang, Y.A., Yan, B.B.; Aasma, M. (2020). A novel deep learning framework: Prediction and analysis of financial time series using CEEMD and LSTM. Expert systems with applications, volume 159. https://www.sciencedirect.com/science/article/pii/S221491471930501X?utm_source=TrendMD&utm_medium=cpc&utm_campaign=Defence_Technology_TrendMD_1 .

Zubarev, A. E. (2017). Digital economy as a form of manifestation of regularities in the development of the new economy. *Vestnik TOGU*, 4 (47): 177-184.

Zhadan, I. E. (2018). Social risks in the digital economy. *Humanitarian scientific journal,* 20-26.

Sudarushkina, I. V., Stefanova, N. A. (2017). Digital economy. *ANI: Economics and management,* 1(18): 182-184.

Chernova, V. Yu. (2019) Russian consumer in the digital economy. *Discussion*, 2 (93): 38-41.

Shvab, K. (2016). *The Fourth industrial revolution*. "Eksmo", Top Business Awards. http://ncrao.rsvpu.ru/sites/default/files/library/k. shvab_chetvertaya promyshlennaya_revolyuciya 2016.pdf .

Digital economy-national projects-Khabarovsk territory. (2020). https://www.khabkrai.ru/khabarovsk-krai/Proekty/175469. (date of request: 08.10.2020)

Official portal "Ministry of digital development, communications and mass communications of the Russian Federation" (2020). https://digital.gov.ru/ru/pages/statistika-otrasli/ .