Mathematical Modeling of the Impact of State Financial Support on the Small Business Development in the Russian Federation and the Arkhangelsk Region*

Svetlana E. Zhura [1[0000-0001-5383-4971]], Irina V. Testova [1 [0000-0003-3406-0231]],
Galina V. Zaruchevskaya [1 [0000-0002-7673-5973]], Lidiya N. Chirkova [1 [0000-0001-8543-5377]]

[1] Northern (Arctic) Federal University named after M.V. Lomonosov, Arkhangelsk, Russia
testovairina@mail.ru

Abstract. Foreign experience shows that by providing support to small businesses, you can get a fairly high return from this sector to the development of the state's economy. In Russia, at the present stage, there is an insufficient contribution of small businesses to GDP. The authors assess the impact and effectiveness of the use of financial and other resources directed by the state to support small and medium-sized businesses. To perform this task, the method of mathematical modeling was used. As a result of the study, the insufficient effectiveness of the impact of state-directed financial resources on the support of small and medium-sized businesses both at the level of the Russian Federation and at the level of the subject of the Russian Federation (Arkhangelsk region) was revealed. The authors believe that to solve the identified problem, it is necessary to use a set of measures to strengthen the impact of the institute of state support on the development of SMEs. These measures should be carried out taking into account the specifics of the regional and sectoral development of the regions.

Keywords: State Financial Support for Small Businesses, Mathematical Autoregressive Models ARIMA, SARIMA, LSTM model of an Artificial Neural Network with Long Short-Term Memory.

1   Introduction

The research is quite relevant since the insufficient contribution of small businesses to the economy is an important problem in Russia at the present stage. The experience of developed countries shows that they provide great support to small businesses and get a good profit from it in the form of taxes, development of innovations, and employment of the country's population. The statistics reflect the high contribution of small businesses to the development of the economies of the world leaders. For example, in the United States, 99.9% (30.7 million) of all companies operate in small businesses. Small

---

companies are the main employer in the US labor market. They create about 1.5 million new jobs annually (TOP-10, 2020).

In Europe, according to Eurostat, Germany is the leader in such indicators of small business development as the number of employees employed in small and medium-sized businesses (SMB) and the total turnover of SMB companies. At the same time, Italy is in first place in terms of the total number of companies, ahead of Germany by more than 1.5 times (3.7 million companies versus 2.4 million in Germany) (International Independent Institute for Agrarian Policy, hereinafter to be referred to as MNIAP).

It stands to reason that in Russia, the national project "Small and Medium-Sized Businesses (SMB) and Support for Individual Entrepreneurial Initiatives" are aimed to increase the contribution of small and medium-sized businesses to GDP to 32.5% by the end of 2024.

Therefore, research is required to solve the problems associated with an increase in the number of small and medium-sized businesses, the number of people employed in the field of SMBs in the Russian Federation and regions of the Russian Federation, the contribution of small businesses to the GDP of the Russian Federation (GRP of the region).

We set a goal to assess the impact and effectiveness of the use of financial and other resources directed by the state to support small and medium-sized businesses.

2　　Literature Review

Much attention is paid to the support of small businesses both nationally and at the international level. The relevant topic has acquired particular importance in the context of the COVID-19 pandemic, which implies the provision of additional measures to support entrepreneurship by the state. In the context of the coronavirus pandemic, the problems of business financial solvency, job preservation, and maintaining partnerships with Russian and foreign suppliers have worsened (Parushina N.V., Starostin M.G., 2020). The assessment of state support for SMBs is carried out on the example of the countries of the European Union and recommendations are given on possible directions for the development of SMBs in Russia (Milkina I., Pavlova M., 2020).

Research is being conducted on the financial investments of the Russian state in support of business following the national project "Small and Medium-Sized Businesses and Support for Individual Entrepreneurial Initiatives" in the context of the economic crisis of 2020 (Bezpalov V.V., Vasina I. V, 2020). Much attention is paid to the analysis of the development of the infrastructure for supporting entrepreneurship in the regions since the COVID-19 epidemic has caused serious consequences thereto and it is noted that the COVID-19 pandemic has highlighted the most painful points of the financial model of interaction between the federal center and the regions and confirmed the need to change the mechanisms of interbudgetary relations (GAPOV M .R., KHUBIEVA D.K., 2020).

3   Methods

In the study of state financial support for the development of small businesses in the Russian Federation, the authors used a set of methods of economic analysis. The statistical and economic method is applied as a set of methods used to comprehensively describe the development of a phenomenon using massive digital data. The research is based on the method of mathematical modeling. To fulfill the set, information was collected from official statistical sources on such indicators as the number of SMBs (units), the number of SMB employees (men), SMB turnover (rubles), gross regional product (rubles), gross domestic product (rubles); the number of subsidies allocated from the federal budget for state support of small and medium-sized businesses in the Arkhangelsk region in the Russian Federation and by regions (for example, the Arkhangelsk region). Data are presented for the Russian Federation for the period from 2007 to 2019. (see Table 1,2) (Rosstat, SMB).

Table 1. Indicators of SMBs in the Russian Federation from 2007 to 2019.

Indicator\Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of small businesses, thousand units	1137,4	1347,7	1602,5	1644,3	1836,4	2003	2063,1	2103,8	2222,4	2770,6	2754,6	2659,9	2659,9
GDP, billion rubles	33247,5	41276,8	38807,2	46308,5	60114	68103,4	72985,7	79030	83087,4	85616,1	91843,2	104629,6	110046,1
The amount of subsidies allocated from the federal budget, thousand rubles	3800000	3900000	18600000	17800000	17867000	20800000	19786882	19374822	18528287	11124625	7510720	5845007	27180874
Average number of employees in small businesses, thousand men	9239,2	11412,1	11192,9	11149	11480,4	11683,9	11695,7	11744,2	11330,7	11040,1	11986,3	11819,8	11819,8

Tools and methods used:

In the course of the research, the mathematical autoregressive models ARIMA, SARIMA were used.

The ARIMA model is an integrated autoregressive model in which the values of a time series at a given moment are linearly dependent on the previous values of the same time series. The general equation of the model is:

$$\triangle^d X_t = c + \sum_{i=1}^{p} a_i \triangle^d X_{t-i} + \sum_{j=1}^{q} b_j \varepsilon_{t-j} + \varepsilon_t$$

(1)

The operation of the model is determined by 3 parameters: p, d, q:

p – dependence of the value of the current period on the past values of the periods;

d - number of differences;

q - dependence of the value of the current period on the prediction errors of the previous periods.

Table 2. Indicators of SMBs in the Arkhangelsk region from 2012 to 2019.

Indicator \ Year	2012	2013	2014	2015	2016	2017	2018	2019
The number of small businesses, units	14216	16918	14190	13660	14186	14095	13453	12800
GRP, billion rubles	472470,9	326924,9	355685,5	400504,6	425630,7	467177,1	514033,4	514033,4
The amount of subsidies allocated from the federal budget, thousand rubles	244168	168436,9	149200	131985,2	74753,42	50771	33114	431264,9
Average number of workers in small businesses, thousand men	67,4	70,2	72,9	86,5	67,8	74,9	70,9	41,251

The SARIMA model was used to account for seasonal components,

SARIMA (p,d,q) (P,D,Q)^S

$\varphi_p(L)\Phi_P(L^S)(1-L)^d(1-L^S)^D y_t = \theta_q(L)\Theta_Q(L^S)\varepsilon_t$

which includes the following parameters:

- p – characterizes the order for the autoregression part of the model;
- d – the order of the integrated series;
- q – characterizes the order for the moving average;
- P – characterizes the order for the auto-regression part of the model, but for the non-seasonal component of the series;
- D – the order of the integrated series, but for the non-seasonal component of the series;
- Q – characterizes the order for the moving average, but for the non-seasonal component of the series;

S – the seasonality value.

The LSTM model of an artificial neural network with long short-term memory was also used.

The LSTM networks are a subset of recurrent neural networks (RNNs). The key concept in LSTM is cell state: a horizontal line across the top of the chart. The state of the cell resembles a conveyor belt. It goes through the entire chain, undergoing minor linear transformations. LSTM decreases or increases the amount of information in the cell state, depending on the needs. The output of the sigmoid layer gives numbers from zero to one, which determines how many percent of each unit of information to skip further. The value "0" means "skip nothing", the value "1" means "skip all".

For development, the programming language Python 3.7 was used. The neural network model was implemented using the Keras library. The Pandas library was chosen to store the datasets. The stat models library is used to implement ARIMA, SARIMA models. The application interface is designed and built using the PyQT5 library.

In the process of solving, the main steps were identified and a functional model of the application was built, in particular, a use case diagram was created using the free software Ideas Modeler. The functional diagram includes the following 3 stages:

Stage 1. At the first stage, data were collected on the number of SMBs in the Russian Federation and the Arkhangelsk region, on the amount of GDP and GRP, on the turnover of SMBs in the Russian Federation and the Arkhangelsk region, on the number of subsidies allocated from the federal budget for state support for SMBs. For forecasting, data on the number of SMB subjects and GRP data were used.

Stage 2. Analysis of the collected data, including the choice of a mathematical model. Autoregression models ARIMA, SARIMA were used for the solution.

Stage 3. Neural network programming for forecasting and visual presentation of the results(see Fig 1,2).
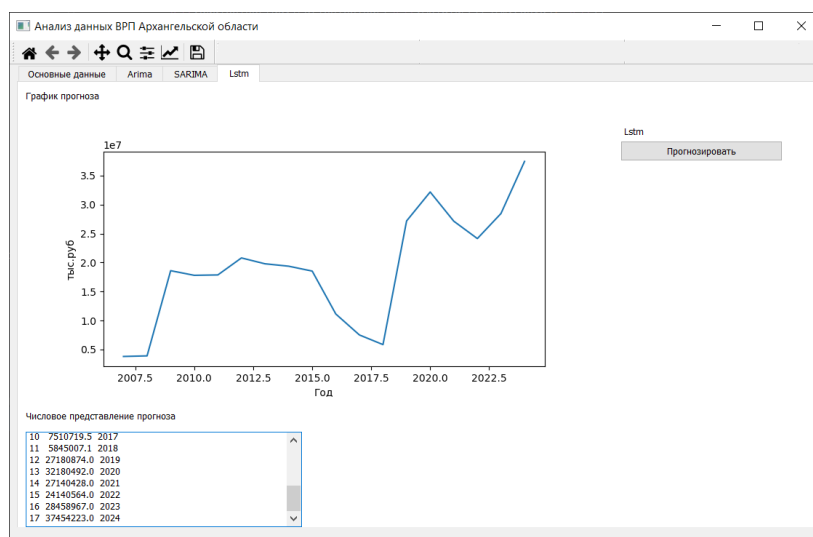
Fig. 1. Application interface with GRP graph with added forecast values for 2021-2023 using a neural network model.
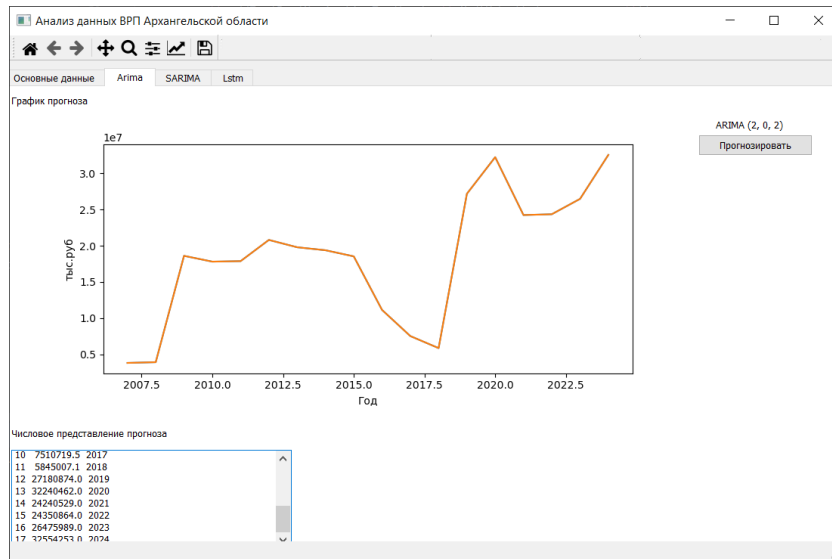
Fig. 2. Application interface with GRP graph with added forecast values for 2021-2023 using the ARIMA model (2,0,2).

To obtain the predicted values and for the convenience of the user, the function of unloading the predicted GRP values into an external output file with the CSV extension has been implemented, the data of which can be used for further processing.

4 Results

The study revealed the insufficient effectiveness of the influence of financial resources directed by the state to support small and medium-sized businesses both at the level of the Russian Federation and at the level of the constituent entity of the Russian Federation (Arkhangelsk region).

Analysis of the impact of subsidies allocated from the federal budget to support small and medium-sized businesses on the dynamics of the number of small and medium-sized businesses and their contribution to GDP (GRP) reflects a low correlation between these indicators (the correlation coefficient varies from -0.4 to 0.15).

Analysis of the impact of subsidies allocated from the federal budget to support small and medium-sized businesses on the average number of people employed in small and medium-sized businesses allows us to reflect a closer relationship at the level of the Russian Federation (the correlation coefficient is 0.45).

5   Discussion

The study of measures of state support for small and medium-sized businesses in Russia, as an external factor affecting the financial stability of enterprises [10] and investments as a factor in the development of small business in Russia [11].

Therefore, it can be stated that the current development of business in Russia is extremely contradictory. Often, the ways to support entrepreneurship, enshrined in regulatory legal acts, are not implemented in practice to the extent that they should. The main problems hindering the systematic provision of assistance from the state are:

- lack of an effective legislative framework;
- increase of the tax burden;
- the bureaucratization of state institutions, which are entrusted with supervisory functions;
- lack of a well-developed system of financing entrepreneurship;
- economic problems (inflation, rising prices in all spheres of production).

6   Conclusion

Given the state priority of the development of the private enterprise sector in the Russian Federation, the resolution of contradictions in the field of private-state dialogue on the most pressing issues of financial, tax and legal protection and support occupies the highest priority both at the level of higher public administration and at the level of local bodies of state municipal administration [12].

To solve the identified problem, we propose the following measures to enhance the impact of the institution of state support on the development of SMBs, the relevant measure shall be carried out taking into account the specifics of regional and industrial development of regions. These measures include:

- increase in control over performance indicators in the implementation of programs to support SMEBs, current and final monitoring of the achievement of indicators should be carried out;

- due regard to the forms and types of economic activities of business operations, the size and stages of the life cycle of entities when providing support to SMBs;

- SMB support programs shall provide funding for improving SMB access to Internet services and creating effective e-business models, as well as representing the interests of business entities at the domestic and foreign levels through specially created information support institutions;

- strengthening support for the innovation sphere, which requires the development of new systems for embedding SMBs in the innovation sphere, taking into account the specifics of the regions;

- activation of measures for consulting and educational support to involve the population in the field of entrepreneurship, the formation of entrepreneurial thinking starting from school, the involvement of students in business, graduates, as well as people who have been left without work.

The entrepreneurial activity contributes to the improvement of the economic and social situation, the development of the middle class in a certain region, and, consequently, to an increase in the effectiveness of the functioning of entrepreneurial activities [13]. Thus, it is necessary to develop new areas of support and development of small businesses, as a small business is a pillar of the development of the economy of our country[14].

Developed small business is an indispensable condition for a stable economy of the country, as well as for individual regions. The most important condition for realizing the potential of small businesses is an effective system of state support for the business entities [15].

References

1. TOP 10 Most Profitable Industries in the US in 2020 | InternationalWealth.info https://internationalwealth.info/offshore-business-abroad/top-10-pribylnyh-otraslej-dlja-biznesa-v-ssha/

2. Small and medium-sized businesses in Europe - MNIAP http: //мниап.рф/analytics/Malyj-i-srednij-biznes-v-stranah-Evropy/

3. National project "Small and Medium-Sized Business and Support for Individual Entrepreneurial Initiatives" | Ministry of Economic Development of the Russian Federation https://www.economy.gov.ru/material/directions/nacionalnyy_proekt_maloe_i_srednee_predprinimatelstvo_i_podderzhka_individualnoy_predprinimatelskoy_iniciativy/

4. Parushina N.V., Starostin M.G., Analysis of state support measures for small and medium-sized businesses in all activity spheres/education and science without borders: fundamental and applied research. - No. 12. - 2020. 160-164 pp.

5. Milkina I., Pavlova M., Foreign experience of state support for small and medium-sized businesses / Municipal Academy. - 4. - 2020. 85-90 pp.

6. Bezpalov V.V., Vasina I. V., State support for small and medium-sized businesses as a tool to ensure the economic security of the state in the context of instability is in place

7. Economic research and development. No 9. 2020. 104-114 pp.

8. Gapov M.R., Khubieva D.K., Development of infrastructure for supporting entrepreneurship in the regions / E-SCIO .- No. 10 (49). 2020. 41-46 pp.

9. Small and Medium-Sized Business in Russia / Rosstat / https://rosstat.gov.ru/folder/210/document/13223?print=1

10. Korshunova, G.V., Shumilina, E.S.: State Support Measures as a Factor Influencing the Financial Stability of Small and Medium Enterprises in Russia. Economics and Business: Theory and Practice. 2019.No. 9. P. 108-110. DOI: 10.24411 / 2411-0450-2019-11170

11. Ashurov, T.Sh., Ataeva, B.M., Abdurakhmanova, N.N.: Evaluation of the Effectiveness of State Financial Support of Small Business Entities in Russia. Economy and Entrepreneurship. 2020. No. 8 (121). PP. 754-756. DOI: 10.34925 / EIP.2020.121.8.154

12. Vashalomidze, E.V., Chalenko, I.A., Krekova, M.M.: Mechanisms of Effective Interaction between State Municipal Administration Bodies and Business in a Pandemic. Economy and entrepreneurship. 2020. No. 12 (125). S. 808-818. DOI: 10.34925 / EIP.2021.125.12.161

13. Kolesnichenko, E.A., Radyukova, Ya.Yu., Dronov, S.E.: Improvement of Measures of State Support of Entrepreneurship at the Regional Level. Bulle-shadow of science and practice. 2018.Vol. 4.No. 10.P. 341-350. DOI: 10.5281 / zenodo.1462003

14. Chistyakova, M.K.: Development of Small Business in the agro-industrial complex. Bulletin of Agrarian Science. 2018. No. 4 (73). S. 115-119. DOI: 10.15217 / issn2587-666X.2018.4.115

15. Adamenko, A.A., Khorolskaya, T.E., Petrov, D.V.: State Support as a Tool for Small Business Development. Scientific and Technical Statements of the St. Petersburg State Polytechnic University. Economic sciences. 2020.Vol. 13.No. 3.P. 57-67. DOI: 10.18721 / JE.13304