

# Development of mathematical model of the system of small businesses

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**Abstract.** The purpose of this work is to develop the model and quantitative parameters of the system of small enterprises. The processes of small business development should be identified, formalized and presented in the form of a mathematical model, allowing the use of forecasting and regulation of the system of small enterprises. Mathematical and statistical research of quantitative changes in the small business system under the influence of various external factors. The indicators most adequately reflecting small business development have been established. External factors that have a predominant influence on the development of small businesses are identified. A mathematical model of a small business was developed. The tools of the conducted research can be used in different countries to improve the level of regulation and forecasting of the system of small enterprises. Developed a mathematical model for development of the system of small enterprises.

## 1 Introduction

Market economy development is directly related to the activities of entrepreneurs, which was earlier shown by J. Schumpeter in his work “The Theory of Economic Development” (1911/1934). According to Schumpeter, the main engine of economic development is an entrepreneur who forms new combinations of things and creates innovations. A large number of works by contemporary authors are devoted to the critical development of these ideas. Z.J. Acs (1992) shows that an entrepreneur transforms new ideas into new products, ensuring growth of economy, its qualitative change and creation of new jobs. A.R. Sabella and co-authors (2014) show the impact of entrepreneurship development on economic growth according to the data from thirteen European countries. Minniti and Lévesque (2006) investigate the role of entrepreneurship in the involvement of unused resources in production. The works by Verkhovskaya O.R. (2009), Alexandrova E.A., Kunin V.A. (2011), Ginjolia O.A. (2012), Valko D.V. (2018) are devoted to institutional issues of entrepreneurship development. D. Valliere and R. Peterson (2009) substantiate the connection of state policy with the development of entrepreneurship and subsequent economic growth in developing countries. The studies by Gwartney (1999), Boettke and Coyne (2009) are devoted to various aspects of the influence of public institutions and state policy. With the objective significance of state policy, the most effective methods for the development of the entrepreneurial sphere

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are yet to be considered. In this connection, it is necessary to determine the objects of state policy in business.

Traditionally, businesses are divided into large, medium-sized and small. Each business sphere differs not only quantitatively, but also qualitatively. Accordingly, state policy should take into account these differences. The object of research in this paper is small business. To substantiate effective measures of state policy in relation to small business, it is necessary to show its systemic nature within the existing variety of activities. Further, it is necessary to identify the sphere of small entrepreneurship and determine which indicators reflect its development most accurately, taking into account the real problems of their statistical formation, and determine how small entrepreneurship development affects economic growth. Then it is possible to form the most effective tools of state policy affecting small business development and its contribution to the growth of the country's economy. The given study is devoted to these tasks.

## **2 Materials and methods**

Applying Schumpeter's approach, an overwhelming majority of researchers focus on the creative role of entrepreneurs who transform ideas into new products, technologies, and services. Accordingly, innovations stimulate economic growth and provide employment growth (Sabella A.R. et al. (2014). Developing the provisions on the positive role of entrepreneurship for economic development, W. Naude (2008) revealed the positive impact of entrepreneurship on the creation of new enterprises, activation of the credit market, increased competition and creation of new high-quality products. An earlier study conducted by Minniti and Lévesque (2006) showed the importance of entrepreneurship in creation of new production facilities, emergence of new forms of distribution and sales. There are a number of other studies that show the positive impact of entrepreneurship on the development of national economies (Audretsch 2002, Wong 2005, etc.). With the evidence of the positive and versatile influence of entrepreneurship on economic development, there is a question of the reverse influence of public institutions and state policy on the development of this area. Minniti (2005) even introduced the concepts of necessary and possible entrepreneurship, emphasizing the differences between countries in the degree of influence of their institutions on the state of entrepreneurship. Studies were conducted to determine the impact of the volume of investments, accessibility and level of technology development, per capita income on the development of entrepreneurship in various countries (Méndez-Picazo, 2012), as well as the impact of formal business rules, bureaucratic procedures and informal public institutions (culture, social values system, etc.) existing in society (Aparicio, 2016). In all the above-mentioned studies, entrepreneurship is considered as a non-state part of the economy, representing a certain integrity. However, objectively there are large, medium and small businesses. Each form of business has a different impact on the economy and has its own specific features. State policy should take into account these features to ensure the maximum possible growth of the economy. To do this, it is necessary to identify business areas themselves for further development of measures to regulate and support them. In the practice of many countries, the criterion for classifying enterprises as small businesses is the number of employees employed by them, and the limit of annual sales volume of these enterprises. It is advisable to decide whether an enterprise belongs to a certain form of business based on its sales share in the industry market in accordance with the provisions of the Harvard paradigm. At the same time, the number of employees employed by the enterprise should not act as a criterion for distinguishing business forms, as it does not have a direct economic impact on the results of its activities, especially in the context of the fourth scientific and technological revolution. The direct implementation of the described approach is complicated by the currently used methods of collecting statistical data. Therefore, countries use different

quantitative indicators to classify enterprises as small, medium and large, due to economic, social and other characteristics, including the organization of national statistics.

In the Russian Federation, small business entities with the lowest share of sales are microenterprises and individual entrepreneurs (sole proprietors). Currently, these small business entities have two criteria restrictions: the average number of employees (no more than 15 people over the past year) and the amount of income (no more than 120 million rubles received over the past year). These criteria restrictions apply both to production and consumer cooperatives, and to farmers, which are essentially small enterprises that have their own organizational and legal forms of creation and functioning. For microenterprises, there are also restrictions on the share of participation in their capital of foreign organizations and legal entities that are neither small nor medium-sized under the current Russian legislation<sup>[33]</sup>.

In modern Russia, small enterprises are seen as different from microenterprises in quantitative values of criteria indicators: the number of their employees can be from 16 to 100 people of the average number according to the results of the past year, and their income (sales volume) should not exceed 800 million rubles (it should be higher than 120 million rubles, but less than 800 million rubles). There are restrictions on the participation of state and municipal enterprises in their capital (no more than 25%), as well as foreign enterprises, and medium or large businesses (no more than 49% for each).

It is essential that all small business entities, without exception, have the right to keep simplified accounting, which may distort the real results of their activities. If we switch from the current selective collection of statistical data in the Russian Federation to an annual and continuous one, while preserving the entire variety of taxation systems for small businesses and their corresponding forms of simplified accounting, objective information about the functioning of this sector of economy will not be obtained. This creates difficulties in developing measures for small business development, since the reliability of information is distorted.

A common point that unites all types of entrepreneurship is the presence of a business idea that forms the basis of creative activity, which has been noted by representatives of the Austrian School of Economics: Ludwig von Mises, Friedrich August von Hayek (Hayek, Friedrich August von, 2000). Similar views are also expressed by Russian economists (Kozyrev V.M., 2015). An important fact is that entrepreneurship, being realized in various forms, has a single target orientation in the form of benefits received as a profit, income or personal benefit, depending on the chosen taxation system and the corresponding forms of accounting and reporting. The mentioned circumstances are the unifying features forming the sphere of small businesses, which allow to consider it as a kind of integrity, an object of research. At the same time, the type of activity, the scale of the business, its capital intensity, the quantity and quality of the attracted workforce, and other aspects of its functioning do not exclude general patterns of small business development, which determines the possibility of using statistical methods of research in this area of social production.

Table 1 presents indicators characterizing the dynamics of small enterprises development in the Russian Federation and indicators reflecting changes in the conditions of their functioning. The indicator “number of small enterprises (without microenterprises)” by type of activity is taken as characterizing the dynamics of small business development, since it most reliably reflects the quantitative changes in this area based on the methods of collecting statistical information that exist today. As a complementary indicator, the number of small manufacturing enterprises is accepted as more stable, capital-intensive, having, as a rule, higher barriers to entry and exit to the market. The results of the activities of small enterprises are characterized by their turnover, an indicator presented in official statistics related to tax bases and giving an approximate idea of the volumes of their production. Accordingly, the indicator for the turnover of small manufacturing enterprises is taken.

**Table 1.** Indicators characterizing small enterprises development and factors affecting them [34].

Years	Number of small enterprises (without microenterprises), thous.	Volume of loans granted to small and medium-sized enterprises, mil.rub.	Number of small manufacturing enterprises, thous.	Russia's GDP (bln.rub.)	Turnover of small enterprises (without microenterprises), bln.rub.	Rates of Russian credit organizations on loans to non-financial organizations, up to 1 year, including "on-demand" (%.)	Real average monthly wages of employees, rub.	Average number of employees, thous. people	Average number of employees (without external part-timers), thous. people	Turnover of small manufacturing enterprises (without microenterprises), bln.rub.
	Y 1	X1	Y2	X2	Y 3	X3	X4	Y4	Y5	Y6
2009	227,8	2516533	36,5	38807	67657,1	13,6	18637,5	10254	10176,2	14423,3
2010	219,7	3873702	35,3	46309	81388,6	9,2	20952,2	10336	10298,3	18761,4
2011	242,7	5149819	34,9	59698	99978,4	9,6	23369,2	7125,9	6557,6	23940
2012	243,1	6023812	35,4	66927	111582	10,3	26628,9	6984,3	6506,8	26308,3
2013	234,5	6933243	33,9	71017	114625,7	10,2	29792	6926,2	6452,3	29520,1
2014	235,6	6568483	33,6	77945	129195	12,49	32495	6832,0	6358,4	32019,6
2015	242,7	4540710	33,9	80804	141547,3	18,86	34030	6660,9	6216,1	34687,2
2016	172,9	4560099	26,3	83898	146376,8	16,46	36709	5388,9	5050,2	37112,1
2017	256,7	5304913	33,2	88177	158778	14,43	39167	6671,8	6167,5	41357,3
2018	238,3	5888453	31,8	103876	191820,6	12,46	43724	6271,7	5800,6	48639,2

Since the number of small enterprises' employees is subject to control by tax authorities, this indicator is adopted to reflect the dynamics of the development of small entrepreneurship, both with part-timers and without them, which is due to the instability of the work of small

businesses, which leads to the fact that some employees prefer not to give up work in their former places of employment.

The availability of credit products is most often considered as the factor influencing small business development.

To verify this provision, the impact of the volume of loans granted to small and medium-sized businesses and the dynamics of the rates of Russian credit institutions on loans granted to non-financial organizations will be studied.

Many economists relate small business development to the general economic situation in the country, since the latter is largely focused on final demand. Therefore, the impact of changes in the country's GDP in comparable prices on indicators characterizing small business development, as well as the impact of the dynamics of the real average monthly accrued wages of employees, will be determined as characteristic of changes in effective demand.

The research tool in this paper is correlation and regression analysis, since there are series of numerical values of indicators that theoretically influence small business development and numerical characteristics describing this area in dynamics.

### 3 Results

Correlation and regression analysis was carried out using specialized EVIEWS software. The analysis results for the impact of factorial feature variations external to the small business system on the performance indicators characterizing its development are as follows (see Table 2).

The regression equation describing the influence of factorial features  $X_i$  ( $i=1,2,3,4$ ) on the effective feature  $Y_1$  is as follows:

$$Y_1 = 0.00000312 X_1 + 0.001227 X_2 - 0.631319 X_3 - 0.002989 X_4 + 226.7203.$$

The selected features  $X_i$  do not have a significant impact on the effective factor  $Y_1$ . The coefficient of determination (R-squared) is only 0.132826. The proportion of variation in the dependent variable  $Y_1$  (the number of small enterprises), explained by the above regression equation with a set of independent variables  $X_i$ , is -0.560914.

**Table 2.** Regression analysis results.

Dependent Variable: Y1				
Method: Least Squares				
Date: 04/21/20		Time: 21:25		
Sample: 1 10				
Included observations: 10				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
X1	3.12E-06	1.45E-05	0.215097	0.8382
X2	0.001227	0.004105	0.298958	0.7770
X3	-0.631319	4.657580	-0.135547	0.8975
X4	-0.002989	0.009069	-0.329644	0.7550
C	226.7203	75.42690	3.005828	0.0299
R-squared	0.132826	Mean dependent var		231.4000
Adjusted R-squared	-0.560914	S.D. dependent var		22.80185
S.E. of regression	28.48784	Akaike info criterion		9.843685
Sum squared resid	4057.786	Schwarz criterion		9.994977
Log likelihood	-44.21842	Hannan-Quinn criter.		9.677717
F-statistic	0.191463	Durbin-Watson stat		3.160972
Prob(F-statistic)	0.932806			

The multiple correlation coefficient characterizing the quality of the regression equation is 0.364453, the tightness of connection is moderate. None of the coefficients of the multiple regression equation, with the exception of the free term of equation C, is significant according to the Student's and Fisher criteria. The probability of insignificance of the multiple regression equation is close to one  $\text{Prob}(F\text{-statistic}) = 0.932806$ .

Thus, the conducted statistical analysis did not confirm the hypothesis that changes in GDP, dynamics of real average monthly wages, volumes and conditions of loan services influence the number of small enterprises. Apparently, such results are explained by the quality of statistical data on the number of small enterprises, that represent the result of sample surveys, which distorts the information about their real number. Besides, many enterprises that can be found in the register do not conduct any activity and are not closed by their founders due to the lack of funds for liquidation procedures or are intended for sale, as they have existed on the market for several years. The latter circumstance makes non-operating enterprises attractive for purchase by initiators of a new business planning to obtain loans when one of the conditions for granting loans from banks is the period of existence of the borrower company on the market. Moreover, households located in rural areas produce up to 70% of fruits and berries in Russia, they are small enterprises in fact, but they are not taken into account by official statistics as such. Undoubtedly, these circumstances affect the results of correlation and regression analysis. The results obtained somewhat contradict both empirical observations and statistics of surveys of small business participants, linking the prospects of their enterprises with how accessible loans will be for them, at what rate and for what time (Ageeva S.D., Mishura A.V.2019). In particular, before the crisis of 2020, the Minister of Finance of the Russian Federation A.G. Siluanov, spoke about the need to increase the volume of lending to small businesses by about ten times to increase the number of people employed in this area by a third<sup>[35]</sup>.

Let us test our hypothesis about the factors influencing small business development on the example of small manufacturing enterprises that are more stable in their work. The calculation data are presented in Table 3.

**Table 3.** Regression analysis results.

<b>Dependent Variable: Y2</b>				
<b>Method: Least Squares</b>				
<b>Date: 04/21/20</b>			<b>Time: 21:26</b>	
<b>Sample: 1 10</b>				
<b>Included observations: 10</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
X1	2.35E-07	1.40E-06	0.167196	0.8738
X2	4.71E-05	0.000397	0.118536	0.9103
X3	-0.090620	0.450677	-0.201075	0.8486
X4	-0.000342	0.000878	-0.390163	0.7125
C	40.51315	7.298454	5.550923	0.0026
R-squared	0.479240	Mean dependent var		33.48000
Adjusted R-squared	0.062633	S.D. dependent var		2.847143
S.E. of regression	2.756539	Akaike info criterion		5.172682
Sum squared resid	37.99254	Schwarz criterion		5.323974
Log likelihood	-20.86341	Hannan-Quinn criter.		5.006714
F-statistic	1.150339	Durbin-Watson stat		2.891445
Prob(F-statistic)	0.430171			

The regression equation describing the influence of factorial features  $X_i$  ( $i=1,2,3,4$ ) on the effective feature  $Y_2$  is as follows:

$$Y2=2.35E-07X1+4.71E-05X2-0.090620X3-0.000342X4+40.51315.$$

The selected features  $X_i$  do not have a significant impact on the effective factor  $Y2$ . The coefficient of determination (R-squared) is 0.479240. The proportion of variation in the dependent variable  $Y2$  (the number of small enterprises in manufacturing), explained by the above regression equation with a set of independent variables  $X_i$  is 0.062633 (Adjusted R-squared). The multiple correlation coefficient characterizing the quality of the regression equation is 0.6922716, the tightness of connection is noticeable, almost the upper limit of the range. However, none of the coefficients of the multiple regression equation, as in the example above, with the exception of the free term of equation C, is significant according to the Student's and Fisher criteria. The probability of insignificance of the multiple regression equation  $\text{Prob}(F\text{-statistic}) = 0.430171$ . Thus, the dynamics of the presented factors does not describe the change in the number of small manufacturing enterprises reliably. At the same time, the effective factor  $Y2$  correlates with the selected factorial features to a greater extent, which supports a reasonable assumption about the quality of statistical data on small manufacturing enterprises in comparison with their total number.

Let us consider the relationship between factorial features  $X_i$  and the effective feature  $Y3$  (turnover of small enterprises), which acts as an analogue of the results of their activity. The regression equation is as follows:

$$Y3= -0.006162X1+2.093172X2- 1319.657X3+0.271129X4+14320.03$$

**Table 4.** Regression analysis results.

Dependent Variable: Y3				
Method: Least Squares				
Date: 05/03/20		Time: 16:28		
Sample: 1 10				
Included observations: 10				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
X1	-0.006162	0.001043	-5.905389	0.0020
X2	2.093172	0.295356	7.086951	0.0009
X3	-1319.657	335.1230	-3.937830	0.0110
X4	0.271129	0.652521	0.415510	0.6950
C	14320.03	5427.129	2.638602	0.0461
R-squared	0.998313	Mean dependent var		124295.0
Adjusted R-squared	0.996964	S.D. dependent var		37198.07
S.E. of regression	2049.762	Akaike info criterion		18.39569
Sum squared resid	21007624	Schwarz criterion		18.54698
Log likelihood	-86.97844	Hannan-Quinn criter.		18.22972
F-statistic	739.7468	Durbin-Watson stat		2.959093
Prob(F-statistic)	0.000000			

The selected features  $X_i$  have a very high impact on the effective factor  $Y3$ . The coefficient of determination (R-squared) is 0.998313, the proportion of variation in the dependent variable  $Y3$ , explained by the given regression equation with a set of independent variables  $X_i$  is 0.996964 (Adjusted R-squared). The multiple correlation coefficient characterizing the quality of the regression equation is 0.999156, the tightness of connection is very high. However, only one of the coefficients of the multiple regression equation 2.093172 at  $X2$ , as well as the free term of the equation C, are significant according to the Student's criterion, and at the same time the Fisher criterion (F-statistic 739.746) is significantly higher than the critical value. The probability of insignificance of the multiple regression equation is negligible.  $\text{Prob}(F\text{-statistic}) = 0.000000$ . Thus, the dynamics of the



presented factors reliably describes the change in the turnover of small enterprises, and the effective factor Y3 correlates to a very high degree with the selected factorial features.

Let us continue with the study of the hypothesis put forward earlier. We shall consider the interrelations between factorial features  $X_i$  and the effective feature Y4 (the average number of employees of small enterprises), reflecting the quantitative parameters of the dynamics of this economic sphere. The regression equation is as follows:

$$Y4 = -0.000360X1 - 0.175718X2 - 187.1599X3 + 0.319995X4 + 14411.13$$

The selected features  $X_i$  have a very high impact on the effective factor Y4. The coefficient of determination (R-squared) is 0.857033, the proportion of variation in the dependent variable Y4, explained by the given regression equation with a set of independent variables  $X_i$ , is 0.742660 (Adjusted R-squared). The multiple correlation coefficient characterizing the quality of the regression equation is 0.925761, the tightness of connection is very high (see Table 5). However, none of the coefficients of the multiple regression equation, as in the above calculations, is significant according to the Student's criterion (with the exception of C), as well as according to the Fisher criterion (F-statistic 15,19816).

**Table 5.** Regression analysis results.

<b>Dependent Variable: Y4</b>				
<b>Method: Least Squares</b>				
<b>Date: 04/21/20</b>			<b>Time: 21:29</b>	
<b>Sample: 1 10</b>				
<b>Included observations: 10</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
X1	-0.000360	0.000421	-0.854086	0.4321
X2	-0.175718	0.119178	-1.474416	0.2004
X3	-187.1599	135.2243	-1.384069	0.2249
X4	0.319995	0.263297	1.215342	0.2785
C	14411.13	2189.882	6.580780	0.0012
R-squared	0.857033	Mean dependent var		7345.170
Adjusted R-squared	0.742660	S.D. dependent var		1630.423
S.E. of regression	827.0925	Akaike info criterion		16.58056
Sum squared resid	3420410.	Schwarz criterion		16.73186
Log likelihood	-77.90281	Hannan-Quinn criter.		16.41460
F-statistic	7.493296	Durbin-Watson stat		2.322963
Prob(F-statistic)	0.024287			

The probability of insignificance of the multiple regression equation is negligible. Prob (F-statistic) = 0.024287. Thus, the dynamics of the presented factors describes the change in the average number of employees of small enterprises, the effective factor Y4 correlates with the selected factorial features to a very high degree, but the coefficients of the regression equation do not seem reliable.

Let us replace the effective feature Y4 with Y5 (the average number of small enterprises' employees without external part-timers). The regression equation is as follows (see Table 6):

$$Y5 = -0.000413X1 - 0.204025X2 - 0.381029X3 + 0.381029X4 + 14629.99$$

The selected signs  $X_i$  have a very high impact on the effective factor Y5. The coefficient of determination (R-squared) is 0.866395. The proportion of variation in the dependent variable Y5, explained by the above regression equation with a set of independent variables  $X_i$  is 0.759511 (Adjusted R-squared).



**Table 6.** Regression analysis results.

<b>Dependent Variable: Y5</b>				
<b>Method: Least Squares</b>				
<b>Date: 04/21/20</b>			<b>Time: 21:29</b>	
<b>Sample: 1 10</b>				
<b>Included observations: 10</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
X1	-0.000413	0.000445	-0.926746	0.3966
X2	-0.204025	0.126072	-1.618327	0.1665
X3	-200.1920	143.0460	-1.399494	0.2205
X4	0.381029	0.278526	1.368018	0.2296
C	14629.99	2316.550	6.315420	0.0015
R-squared	0.866395	Mean dependent var		6958.400
Adjusted R-squared	0.759511	S.D. dependent var		1784.132
S.E. of regression	874.9334	Akaike info criterion		16.69303
Sum squared resid	3827542.	Schwarz criterion		16.84432
Log likelihood	-78.46513	Hannan-Quinn criter.		16.52706
F-statistic	8.105922	Durbin-Watson stat		2.295878
Prob(F-statistic)	0.020657			

The multiple correlation coefficient characterizing the quality of the regression equation is 0.930803, the tightness of connection is very high. However, none of the coefficients of the multiple regression equation, as in the above calculations, is significant according to the Student’s criterion (with the exception of C), as well as according to the Fisher criterion (F-statistic 15,19816). The probability of insignificance of the multiple regression equation is negligible. Prob (F-statistic) = 0,020657. Thus, the dynamics of the presented factors describes the change in the average number of employees of small enterprises without external part-timers, the effective factor Y5 correlates with the selected factorial features to a very high degree, but the coefficients of the regression equation do not seem reliable, although somewhat higher than in the case of Y5. To determine the impact of the nature of small enterprises’ activities on their susceptibility to changes in the external factors under consideration, we shall construct a regression equation describing the influence of signs Xi on the productive factor Y6, the turnover of small manufacturing enterprises.

**Table 7.** Regression analysis results.

<b>Dependent Variable: Y6</b>				
<b>Method: Least Squares</b>				
<b>Date: 05/03/20</b>			<b>Time: 16:30</b>	
<b>Sample: 1 10</b>				
<b>Included observations: 10</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>
X1	-0.000964	0.000333	-2.890161	0.0342
X2	0.340443	0.094379	3.607202	0.0154
X3	-351.3944	107.0861	-3.281419	0.0219
X4	0.594409	0.208508	2.850766	0.0358
C	-2475.212	1734.199	-1.427294	0.2128
R-squared	0.997784	Mean dependent var		30676.85
Adjusted R-squared	0.996011	S.D. dependent var		10370.79
S.E. of regression	654.9864	Akaike info criterion		16.11396
Sum squared resid	2145036.	Schwarz criterion		16.26525
Log likelihood	-75.56979	Hannan-Quinn criter.		15.94799
F-statistic	562.8312	Durbin-Watson stat		3.577516
Prob(F-statistic)	0.000001			

The regression equation is as follows:

$$Y_6 = -0.000964 X_1 + 0.340443 X_2 - 351.3944 X_3 + 0.594409 X_4 - 2475.212$$

The selected signs  $X_i$  have a very high impact on the effective factor  $Y_6$ . The coefficient of determination (R-squared) is 0.997784, the proportion of variation in the dependent variable  $Y_6$ , explained by the given regression equation with a set of independent variables  $X_i$  is 0.996011 (Adjusted R-squared). The multiple correlation coefficient characterizing the quality of the regression equation is 0.998004, the tightness of connection is very high, but slightly lower than at  $X_3$ . However, only one of the coefficients of the multiple regression equation, 3.607202 at  $X_2$ , is significant according to the Student's criterion, but the obtained value of the Fisher criterion (F-statistic 562.8312) is significantly higher than the critical value. The probability of insignificance of the multiple regression equation is negligible. Prob (F-statistic) = 0.000001. Thus, the dynamics of the factors presented reliably describes the change in the turnover of small manufacturing enterprises, and the effective factor  $Y_6$  correlates to a very high degree with the selected factorial features. The obtained data show that the tightness of connection of the effective feature  $Y_6$  with  $X_i$  is only slightly weaker than with the effective feature  $Y_3$ , which reflects the characteristics of small manufacturing enterprises in comparison with their total aggregate.

Thus, the correlation and regression analysis made it possible to find an indicator characterizing the development of small business system – the turnover of small enterprises – the value of which is very highly determined by changes in factorial features characterizing, according to most Russian scientists, the main conditions for the development of this sphere of social production. This indicator can serve as one reflecting the results of implementation of small business development regulation programs, and the resulting multiple regression equation opens up the possibility of using the method of correlation and regression analysis to predict the processes of small enterprises' development under the influence of external factors.

## 4 Discussion

The data obtained show that it is advisable to conduct research on small enterprises based on mathematical models enabling to predict the consequences of certain measures aimed at small business development with a high degree of probability, rather than relying solely on sometimes contradictory empirical data and purely theoretical conclusions. In fact, the national small business statistics requires improvement to present a more accurate reflection of the processes taking place in this area to apply mathematical and statistical methods of forecasting its dynamics and work out prompt and effective measures for small business development. It should be borne in mind, that until now, some small businesses are used to cash out funds. Other small business entities do not carry out production and economic activities and are not liquidated for financial reasons. In small business, the non-observed economy is much more widespread than in other forms of entrepreneurship. Its accounting methods have country differences. These circumstances make it difficult to compare the levels of small business development in different countries. Therefore, references to international experience, as an example to follow and reproduce in domestic practice, require additional research. Data on the small business sector may vary in different countries due to different criteria for classification of enterprises, which should be brought to a single fundamental methodology.

The goals for the volume of lending to small enterprises, defined at the state level, do not correspond to the above calculations. In addition, empirical data show that up to a third of small businesses do not use loans at all. They are funded by their founders and work without attracting loans, considering borrowings too risky with uncertain sales prospects for the

increase in output. The problems of lending to small enterprises can be of a spatial nature too (Ageeva S.D., Mishura A.V., 2019).

The approach to regulating the sphere of small business, as a kind of integrity with quantitative internal differentiation of its subjects is fundamental in the activities of public authorities and is largely justified by the consistency of small business. Many Russian economists hold similar views (Anoshkin A.N., 2014).

Indeed, the nature of interaction with the external environment, the level of competition, and goal-setting are of a general nature. At the same time, small businesses create a certain set of goods and services, have a certain territorial distribution and demonstrate sometimes implicit interconnections by sources of raw materials, localized product sales markets, similar technological processes, forms of interaction with government authorities, etc. All these factors form the sphere of small business as a system and justify the application of unified regulatory approaches to it. At the same time, small businesses are industry-specific, they are influenced by the peculiarities of the region of their presence and a number of other factors. The scale of small business is determined by:

- the existing and time-varying demand for a relatively small volume of their products and services;
- the market of means of production, ensuring the activities of small enterprises;
- the development of information and logistics systems in the region of presence;
- the adequacy of small business forms, reporting and taxation of the effectiveness of its activities.

In addition to development and implementation of macroeconomic measures to stimulate small business development, the above-mentioned circumstances make it necessary to create programs to support small businesses, depending on the type of their activity and taking into account their location. The implications of a set of such measures should be assessed systematically using mathematical and statistical methods based on qualitative initial data.

## 5 Conclusion

The conducted research confirmed the systemic nature of the small business sphere and the possibility to apply a policy with unified conceptual approaches based on mathematical modeling. The consistency of small business allows to employ the methods of correlation and regression analysis for the purposes of its research, forecasting its development, assessing the impact of factors on the resulting features of this system. At the same time, the calculation results showed that the most indicative parameter characterizing small business development in the Russian Federation is currently the aggregate turnover of its constituent enterprises. This indicator is sensitive both to regulatory impacts and to changes in the macroeconomic conditions of the small businesses functioning. In addition, the aggregate turnover of small enterprises gives an idea of the contribution of this sphere of social production to the country's GDP to a certain extent.

The above calculations show that the number of small enterprises' employees is less sensitive to changes in macroeconomic conditions external to small business and can only indirectly characterize the dynamics of this field of activity. At the same time, it is the number of employees that is currently considered as one of the indicative parameters when determining the goals of its development. In order to increase the efficiency of the national system of forecasting and indicative planning of small business development, it seems necessary to switch to accounting for the volume of sales of products and services by small enterprises. The use of digital technologies will ensure the collection of this data on an ongoing basis. In its turn, sales volume accounting will create prerequisites for the transition to a unified system of small enterprises taxation. The currently existing various small enterprises taxation systems facilitate tax evasion. At the same time, it is advisable to account

for small enterprises and medium-sized businesses at the state level separately. Medium-sized business is similar to large companies, having no fundamental differences with them. The differences are in the qualitative and quantitative characteristics of enterprises, the technologies used, transfer batches shipped or the volumes of raw materials purchased, the specialization of structural units, the availability and price of loans, etc. All these factors are related to business transformation, when its scale changes, but there are no fundamental qualitative differences. That is why, a number of countries do not separate medium and large businesses in national statistics

Consistent implementation of the model of development of the small business system provided in the work will require changes in statistical data collection, the sectoral division of public production and, in the future, unification of the taxation system of small businesses using unified tax bases. The transformation should result in a new, effective mechanism for small business development based on mathematical and statistical models of the type justified in this research.

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