A Study of Entrepreneurial Activity of the Population in Regions of the Russian Federation by Means of Panel Data Analysis

Ekaterina Ju. Liskina[1][0000−0002−4169−6062] and
Olga P. Serova[2][0000−0002−3550−8838]

[1] S. A. Esenin Ryazan State University, Ryazan, Russia
katelis@yandex.ru
[2] EPAM, Ryazan, Russia
lyolka92@gmail.com

Abstract. This work aims to construct the best regression model in which small business density is the indicator of the level of the population's entrepreneurial activity. The regressors are the volume of investments into the fixed capital of small businesses, the rate on insurance contributions for individual entrepreneurs to extra-budgetary funds of the Russian Federation, and the loan rate for small business. The pooled model, the unrelated model, the fixed effects model, the random effects model are constructed, and their statistical characteristics are calculated. We verify statistical hypotheses about the choice of the most preferred model according to the criteria of Wald test, Breusch – Pagan LM-test, and Housman test. We select the best model. Based on obtained results we propose a classification of the regions of the Russian Federation by the type of the dependence of their entrepreneurial activity on the regressors. We analyze all regions and construct the best regression model for each of them. The unrelated regression model is found to be the best for each group of regions. The authors suggest that strong differences between the regions can be attributed to qualitative factors, such as registration procedures of small businesses, the rate of regional taxes, etc. The results of the study can be used in state and municipal programs of small business development to improve forecasting of economic development of each region of the Russian Federation. Also, we point out that to boost entrepreneurial activity in different groups of regions, different adjustments are required, such as reduction of the rate on insurance contributions for individual entrepreneurs, improvement of the investment climate, or loan rates for small businesses.

Keywords: panel data, economy of Russia, entrepreneurial activity, small business density, pooled model, unrelated model, fixed effects model, random effects model, decision making for small business support

1 Introduction

Small business is an important factor in the development of the economy as it is most susceptible to changes in market conditions and state tax policy. The

level of development of small business is an indicator of the well-being of the economy as a whole. Small and medium entrepreneurship research has been intensively developing since the late 1980s. An overview of different areas of the research can be found in the works of A. Yu. Chepurenko [17, 18]. Dynamics of entrepreneurship development in countries worldwide is evaluated through two global monitoring programs: "Panel study of dynamics of entrepreneurship" (PSED) and "Global entrepreneurship monitor" (GEM) [1, 6].

The entrepreneurial activity of the population is one of the small business development indicators. Entrepreneurial activity is a qualitative dynamic indicator of entrepreneurial capacity in current business climate [10]. The level of entrepreneurial activity in Russian regions is estimated using monitoring programs and ratings [2–4, 9]. Ratings [3, 4, 9] evaluate investment climate in regions including the area of small business. However, ratings do not allow evaluating the degree of influence of various factors on the entrepreneurial activity of the population of Russia. It is therefore important to identify the type, degree, and regional specifics of the individual factor influence on the entrepreneurial activity level of the population of our country. This knowledge will allow us to scientifically substantiate the ability to control national economic growth by stimulating small business via the most influential economic factors. For example, the importance of the research of entrepreneurial performance as the government participation function is discussed in [16].

At the moment there is a very limited body of works devoted to statistical analysis of the factors influencing entrepreneurial activity and econometric business modeling in Russia. In particular, Pin'koveckaja Ju. S. [13] constructed a two-factor exponential production function and showed the dependence of small business turnover on investment in fixed capital and wages. Gorlov A. V. [8] investigated the degree of influence of macroeconomic factors on the economic activity of small manufacturing businesses (WFP). The endogenous variable was the volume of WFP output; the following factors were considered: average number of employees of WFP, investment in fixed capital, export of goods and services, foreign investment in the Russian economy, and others. On the basis of a selected set of most influential factors, he developed a multi-factor production Cobb–Douglas function describing the volume of output of small businesses. Using the constructed model, the author constructed the forecast of small business production volume dynamics for the planning period of 2016–2018.

Unlike the above works [8, 13], we developed an econometric model of the entrepreneurial activity of the population of Russia based on a number of macroeconomic factors: investment in fixed capital of small businesses, the rate of insurance contributions for individual entrepreneurs, and the average interest rate on loans for small businesses. The density of small businesses is an endogenous variable and a quantitative characteristic of the population entrepreneurial activity level (see [9]). The density of small businesses is equal to the ratio of the number of small enterprises to the number of economically active population. Such definition eliminates the effects associated with the distribution of the economically active population in the country.

2 Setting of the problem

We use the following symbols:

SB – Small Business – the number of small businesses in the Russian Federation;

EAP – Economically Active Population – the number of economically active population of the Russian Federation, in thousands;

$\mathrm{SBD} = \frac{\mathrm{SB}}{\mathrm{EAP}}$ – Small Business Density;

I – Investments – the volume of investments into fixed capital of small businesses, thousand rubles;

IC – Insurance Contributions – the tax rate on insurance contributions for individual entrepreneurs to extra-budgetary funds of the Russian Federation (before 2010 – the unified social tax);

LR – Loan Rate – the average rate for small business loans;

t – year ($t = \overline{2000;\ 2014}$);

n – region index number ($n = \overline{1;\ 79}$).

The regions (Federation subjects) of Russia are the objects of the study. We collected panel data of listed statistical economic indicators in all regions from 2000 to 2014 [5]. The panel is balanced since the data is present for all regions and points in time (total 1185 cases). In the selected period the economic system of Russia had a stable structure. Significant structural changes occurred at the boundaries of this period for the following reasons:

1. the first and second parts of the existing Tax Code were adopted in 1999 and 2000, which had a significant influence on the structure of the economy as a whole [12];
2. the current structure of insurance premiums to non-budgetary funds of the Russian Federation, unified for all types of employers and employees, was adopted in 2001;
3. the Republic of Crimea was annexed by Russia in 2014.

In [11] and [14] we studied the dependence of SBD on I, IC, and LR, by methods of regression analysis. We used the cross-data of the constituent entities of the Russian Federation in each year of the considered period. We showed that the linear dependence of the density of small businesses on these factors results in the best statistical characteristics:

$$\mathrm{SBD} = a_0 + a_{\mathrm{I}}\mathrm{I} + a_{\mathrm{IC}}\mathrm{IC} + a_{\mathrm{LR}}\mathrm{LR}. \tag{1}$$

In this paper, we formulate the task to identify regional differences that influence the level of entrepreneurial activity of the population by panel data analysis method and carry out the grouping of regions according to the degree of regional differences.

The calculations are performed using the Microsoft Excel add-in “data Analysis”. The level of significance is 0.05.

3 Experimental research

In accordance with the theory [7], we constructed the following models of panel data: the pooled model (OR-model), the unrelated model (UR-model), the fixed effects model (FE-model), and the random effects model (RE-model).

Statistical characteristics of the constructed models are presented in Table 1.

Table 1. Statistical characteristics of the constructed models

Model	R^2	The residual sum of squares (RSS)
OR-model	0.25	76773.51
UR-model	$R^2_{\min}$= 0.17, $R^2_{\max}$= 0.95	17797.70
FE-model	0.41	32502.81
RE-model	0.40	39726.79

For the constructed models at a significance level of 0.05 we tested the following base hypotheses:

1. about absence of individual differences (Wald test on the insignificance of individual coefficients, OR-model preferable to FE-model);
2. about absence of relationship between regions (Wald test on the insignificance of the coefficients on the regressors in the FE-model, UR-model preferable to FE-model);
3. about absence of relationship between regions (Wald test on the insignificance of the coefficients on the regressors in the RE-model, UR-model preferable to RE-model);
4. about the absence of random individual differences (Breusch – Pagan LM-test);
5. about random individual differences preferable to fixed effects (Housman test, we used the evaluation in the form of the auxiliary regression equation $\mathrm{SBD}(\lambda) = X(\lambda)\alpha + Z_W\gamma + \varepsilon$, matrix $X(\lambda) = (\mathrm{I}(\lambda),\ \mathrm{IC}(\lambda),\ \mathrm{LR}(\lambda))$ is constructed according to the adjusted data for the RE-model, $\lambda = 1 - \sqrt{\frac{\tilde{\sigma}_v^2}{\tilde{\sigma}_v^2 + T\tilde{\sigma}_u^2}}$, $\tilde{\sigma}_v^2$ is the estimation of residual variance of the OR-model, $\tilde{\sigma}_u^2$ is the estimate of the variance of random effects, $T = 79$; matrix $Z_W = (\mathrm{I}_W,\ \mathrm{IC}_W,\ \mathrm{LR}_W)$ is constructed according to the adjusted data for the FE-model, base hypotheses: $\gamma = 0$).

The test results of all hypotheses are shown in Table 2.

We made the following conclusions based on Table 2:

1. Wald test on the insignificance of individual coefficients of the FE-model showed that individual differences between regions are significant, i.e., the FE-model was preferable to the OR-model;

Table 2. Verification of statistical hypotheses on the choice of the best model

Test	value		Conclusion about base hypotheses
	factual	critical	
1) Wald (OR-model preferable to FE-model)	536.65	2.61	reject
2) Wald (UR-model preferable to FE-model)	– 178.26	2.61	accept
3) Wald (UR-model preferable to RE-model)	–217.49	2.61	accept
4) Breusch – Pagan LM-test (OR-model preferable to RE-model)	2433.18	3.84	reject
5) Housman (RE-model preferable to FE-model)	$P_{\gamma_{\text{IC}}} = 2.6 \cdot 10^{-29}$	0.05	reject

2. Wald test on the insignificance of the coefficients on the regressors in the FE-model showed that the factor coefficients are insignificant; i.e., the individual fixed differences of regions such that the regions can not be combined in the FE-model;
3. Wald test on the insignificance of the coefficients on the regressors in the RE-model showed that the factor coefficients are insignificant; i.e., the individual random differences of regions such that the regions can not be combined in the RE-model;
4. Breusch – Pagan LM-test showed that the RE-model was preferable to the OR-model;
5. Housman test showed that RE-model was preferable to the FE-model.

Based on 1–5 we can put the studied models in the ascending order of preference: OR-model, FE-model, RE-model, UR-model. In other words, with a probability of 0.95, the individual differences of the regions are random but so significant that the UR-model is the best to construct the dependence of SBD on I, IC, and LR.

We then analyze the significance of the coefficients of the regressors for each equation of the UR-model, perform the correlation analysis of the factors for each region's data, and classify the regions according to the type of dependence of SBD on I, IC, and LR. The classification results are presented in Table 3.

We drew the following conclusions from Table 3 (significance level of 0.05).

1. There is no Russian region for which all three regressors of equation (1) are significant.
2. The most numerous group consists of the regions where the small business density is determined by the volume of investments into fixed capital of small enterprises (the regression equation has the form $\text{SBD} = a_0 + a_{\text{I}}\text{I}$, group No 3).

Table 3. Classification of the regions of the Russian Federation by the type of regression

No	Regression equation	Regions of the Russian Federation
1	$SBD = a_0 + a_I I + a_{LR} LR$	Regions: Belgorod, Moscow; Stavropol Krai
2	$SBD = a_0 + a_I I + a_{IC} IC$	Regions: Rostov, Ivanovo, the Kabardino-Balkar Republic, Republic of Buryatia, Zabaykalsky Krai, the Jewish Autonomous region
3	$SBD = a_0 + a_I I$	Regions: Voronezh, Lipetsk, Orel, Kursk, Pskov, Tver, Tula, Smolensk, Volgograd, Kirov, Nizhny Novgorod, Orenburg, Penza, Samara, Saratov, Ulyanovsk, Kemerovo, Amur, Bryansk, Vladimir, Kostroma, Kaluga, Tambov, Yaroslavl, Arkhangelsk, Novgorod, Astrakhan, Novosibirsk, Omsk, Irkutsk, Kurgan. Republics: Adygea, Dagestan, Bashkortostan, Mordovia, Chuvashia, Tyva, Mari El, Udmurt, Karachay-Cherkess, Karelia, Tatarstan, Altai. Krai: Krasnodar, Altai, Krasnoyarsk, Kamchatka, Primorsky, St-Peterburg-city
4	$SBD = a_{IC} IC$	Region: Ryazan, Tomsk, Sverdlovsk, Magadan, Sakhalin, Tyumen. Republics: North Ossetia-Alania, Khakassia, Sakha (Yakutia), Komi. Krai: Khabarovsk, Perm
5	$SBD = a_0 + a_{LR} LR$	Chukotka
6	No significant coefficients of regressors in the equation (1)	Region: Vologda, Kaliningrad, Murmansk, Leningrad, Chelyabinsk Republic: Kalmykia, Ingushetia. Moscow-city

3. There is a group of regions in which the SBD does not depend on any of the regressors (group No 6).
4. In groups 1–3, the regression equation contains the volume of investments into fixed capital of small enterprises. Therefore, there is a possibility to manage small business growth by attracting investments in these regions.
5. Control at the Federal level affects the development of small businesses in groups 1 and 4, and group 4 – only at the Federal level.
6. Control of small business development can be realized through improvement of credit conditions in the regions that fall into groups 1 and 5. For a single region in group 5, such control is possible only via improving credit conditions.

We supplement this research with an analysis of partial panels formed by groups 1–4. We identified regional differences within each group and analyzed

the nature of these differences (fixed or random). The results of this analysis are presented in Tables 4 and 5.

Table 4. Statistical characteristics of regression models based on the partial panels of the groups 1–4

Group number	Model	R^2	The residual sum of squares (RSS)
1	OR-model	0.34	1102.00
	UR-mode	$R^2_{\min}$= 0.79; $R^2_{\max}$= 0.86	205.09
	FE-mode	0.37	736.00
	RE-mode	0.58	1158.56
2	OR-mode	0.44	2896.02
	UR-mode	$R^2_{\min}$= 0.66; $R^2_{\max}$= 0.80	905.31
	FE-mode	0.58	2372.19
	RE-mode	0.54	2475.35
3	OR-mode	0.16	52733.36
	UR-mode	$R^2_{\min}$= 0.42; $R^2_{\max}$= 0.95	9086.06
	FE-mode	0.02	172287.67
	RE-mode	0.39	139821.51
4	OR-mode	0.30	10969.42
	UR-mode	$R^2_{\min}$= 0.28; $R^2_{\max}$= 0.49	7755.74
	FE-mode	0.37	8108.54
	RE-model	0.56	10382.36

Thus, we found that the UR-model was the best model in each group of regions. We can explain this fact by the presence of local qualitative factors influencing the level of regional entrepreneurial activity. Those factors might include procedures of registration of small businesses, rates of regional taxes, etc.

4 Conclusion

In this paper, we developed a regression model of entrepreneurial activity level (i.e., small business density) of Russian population using panel data analysis. Explanatory variables were the volume of investments into fixed capital of small businesses, the rate of contributions to extra-budgetary funds of the Russian Federation for small businesses, and the average interest rate on loans to small businesses. We classified the regions based on the explanatory variables influence degree on the small business density. We studied each region group separately and found that UR-model was the most suitable. It can be explained by the presence of local qualitative factors influencing the level of regional entrepreneurial activity, including business regulations.

Previously the authors determined the presence of a direct positive linear correlation between 1) the density of small businesses and employment (includ-

Table 5. Verification of statistical hypotheses on the choice of the best model for each partial panel

Group number	Test	value		Conclusion on base hypotheses	The best model
		factual	critical		
1	1) Wald (OR-model preferable to FE-model)	10.69	3.21	reject	UR-model
	2) Wald (UR-model preferable to FE-model)	–15.51	3.21	accept	
	3) Wald (UR-model preferable to RE-model)	–17.69	3.21	accept	
	4) Breusch – Pagan LM-test (OR-model preferable to RE-model)	17.30	3.84	reject	
	5) Housman (RE-model preferable to FE-model)	$P_{\gamma_{\mathrm{I}}} = 0.42$, $P_{\gamma_{\mathrm{LR}}} = 1.4 \cdot 10^{-4}$	0.05	reject	
2	1) Wald (OR-model preferable to FE-model)	9.72	3.1	reject	UR-model
	2) Wald (UR-model preferable to FE-model)	–27.21	3.1	accept	
	3) Wald (UR-model preferable to RE-model)	–27.91	3.1	accept	
	4) Breusch – Pagan LM-test (OR-model preferable to RE-model)	16.58	3.84	reject	
	5) Housman (RE-model preferable to FE-model)	$P_{\gamma_{\mathrm{I}}} = 0.20$, $P_{\gamma_{\mathrm{IC}}} = 0.01$	0.05	reject	
3	1) Wald (OR-model preferable to FE-model)	1199.40	3.89	reject	UR-model
	2) Wald (UR-model preferable to FE-model)	–696.29	3.89	accept	
	3) Wald (UR-model preferable to RE-model)	–686.30	3.89	accept	
	4) Breusch – Pagan LM-test (OR-model preferable to RE-model)	18.96	3.84	reject	
	5) Housman (RE-model preferable to FE-model)	$P_{\gamma_{\mathrm{I}}} = 4.2 \cdot 10^{-84}$	0.05	reject	
4	1) Wald (OR-model preferable to FE-model)	63.15	3.89	reject	UR-model
	2) Wald (UR-model preferable to FE-model)	–7.79	3.89	accept	
	3) Wald (UR-model preferable to RE-model)	–45.28	3.89	accept	
	4) Breusch – Pagan LM-test (OR-model preferable to RE-model)	5452	3.84	reject	
	5) Housman (RE-model preferable to FE-model)	$P_{\gamma_{\mathrm{IC}}} = 1$	0.05	accept	

ing self-employment) of the population, and 2) between the density of small businesses and a gross regional product [15]. Increasing the density of small businesses boosts employment and gross regional product. Therefore, the results of this study can be used in state and municipal programs of small business development to forecast economic development of each region of the Russian Federation. The region classification (Table 3) demonstrates that a change in economic factors might lead to a larger economic effect. In particular, a significant increase of entrepreneurial activity can be achieved by reducing the rate on insurance contributions for individual entrepreneurs at the Federal level. For most areas, both state and regional measures are important in order to improve the investment climate. In two groups of regions the entrepreneurial activity can be boosted by regulating the rate of small businesses loans.

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