

# Production Functions Small Enterprises and Microenterprises: Russian Regions Data for 2018



Iuliia Pinkovetskaia, Igor Balynin

**Abstract:** *The entrepreneurship started in Russia during the process transformation of state economy into market economy, beginning from 1992. The aim of the study was to assess the production functions that describe the volume of production small enterprises in all Russian regions. This functions explain dependence of the amount of release of small enterprises and microenterprises on the salary of their workers and investments in fixed capital. During the research was made assess of two-factor degree production functions that describe the dependence of the volume of production small enterprises on the wages of their employees and investments in fixed assets. Evaluation of functions was made on methods of regression analysis and linearization. The research was based on official empirical territorial data describing the work of small enterprises and microenterprises. In the paper we used statistical information on 82 regions, territories, areas of Russian Federation for 2018. We proved the high quality of approximation of the initial data by the two-factor production functions. Evaluated production functions have increasing return to scale. Proved that economy of Russian regions has not reached saturation with products of small enterprises and microenterprises. They have significant reserves for further development. That is, in all regions there are opportunities to increase the number of enterprises and the number of employees in them. Results of the study and tools for evaluation production functions can be applied in the studying of Russian entrepreneurship, in explanation of the development plans for this economic sector. Such information can be used by governments, regional authorities and municipal management. The methodic and software that were applied in the study process can be used in making analogous studies in various countries with a considerable amount of territories.*

**Keywords:** *production function, Russia, small enterprise, microenterprise, investments, salary.*

## I. INTRODUCTION

Currently, there is no doubt about the importance of small entrepreneurship for economic development. At the end of the XX century in most developed countries small enterprises and microenterprises significantly increased their share in gross

domestic product and the number of employees [1], [2]. These enterprises act as the main sources of economic growth, the creation of new markets, and satisfying the population's need for jobs [3].

The entrepreneurial sector in most countries is the main driver for national economy, growth volumes of production in regions, especially in underdeveloped countries, creates the conditions for economic restructuring. About this wrote such researches [4], [5]. For this reason, in 21 century, small entrepreneurship is getting significant part of national economies not only in developed, but also in developing countries. In spite of small enterprises and microenterprises appear in Russia after 1990, their quantity increasing constantly. In 2018 amount of such firms was 2.660.000. Number of their employees was 14.820.000. Along with that, the ratio of small enterprises and microenterprises in whole GDP amount in Russia was not big, it was 18%. About this quality was also number of workers of all Russian organizations. For comparison can be pointed statistical data on European Union. In it small enterprises and microenterprises ensure generation of 58% of GDP in these countries [6]. They ensure work for about 67% economic active people.

Such values in Germany are 60% and 48% accordingly [7]. This explains that the part of small enterprises and microenterprises to economy of the Russian Federation is irrelevant. So we have an urgent necessity for the high development of small enterprises and microenterprises in Russia. Understanding management tasks in the Russian economy requires evaluation of the indicators that impact on the turnover of small enterprises and microenterprises. As presented in Russian researches [4], [8], [9] entrepreneurial sector created the preconditions of accelerated regional development, especially in regions with low level of production goods and services. Therefore, in the crisis conditions, one of the most urgent problems in the Russian Federation is proving the increase reserves of entrepreneurial sector in the country and its regions. The justification of such reserves, as well as the assets, which can provide more effective operating of small enterprises and microenterprises, can be relying on economic-mathematical models. As such models valuable to take so called production functions. Production functions are widely used both in Russia and other countries in the analysis and management of socio-economic processes. At the origins calculation of production functions was such famous researches Cobb and Douglas [10]. They proposed for estimation dependence of the turnover to use factors labor cost and capital investments in companies.

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In details methodology and theoretical base of production functions were presented in more late work by Douglas [11]. In it he discussed the evolution functions development.

The aim of this research is to evaluate the production functions, characterizing turnover on small enterprises and microenterprises.

**II. LITERATURE REVIEW**

In recent time were conducted much researches in which were developed production functions. Part of these researches were dedicated to small business. These functions characterise dependencies turnover of enterprises from two factors. Such factors were basic funds (the value of all houses, constructions, machine equipment, computers) and cost on employees. Modern academia discusses various indicators of labor input. From paper in which describes production functions much interest represent such [12]. In this work cost on employees estimates as expenses on wage of workers. The study [13] considers the indicator of the yearly person-hours total number. One should also note that most researches observe their data based on time information. For example, article [14] uses data for fifteen years from 1990. The influence has been proved of the workers number and fixed capital on the real GDP of India, Bangladesh, China, Malaysia and Thailand. Evaluation of these factors influence on the turnover of entrepreneurship in Pakistan is presented in [15].

In the researches by Bessonov and Tsukhlo [16] and Kleiner [17] was presented the opportunity on broad practical application of production functions in analysis production processes and creative management. Herewith mentioned authors offer production functions as economic-mathematical models of production procedures. These models describe regularities archived relations between factors and turnover. Therefore these production functions can be used for describing modeling regularities and tendencies, characterizing functioning different economic and entrepreneurial aggregates and systems, from firms, organizations, corporations to areas, territories, sectors of the economy and countries as a whole.

Most frequently applied functions similar to Cobb-Douglas functions. Table I presents the characteristics of power production functions on the information of recent years from Russian researches. In column four sign plus means yes, and minus means no.

**Table- I: Features of Russian researches**

Researcher	Indicator of assets	Indicator of labour	Limits on the sum of degrees indicators
1	2	3	4
Nosov and Aznabaeva [18]	fixed capital	quantity of workers	-
Sokol, Kutychkin and Petrov [19]	investment in fixed assets	labour expenditures	+
Nikonorov [20]	fixed assets	number of employees	-

Pshenichnikova and Romanyuk [21]	gross assets accumulation	quantity of workers	-
Adamaliev and Khalilov [22]	investment in fixed assets	quantity of workers	-
Sadovin and Kokotkina [23]	fixed capital	quantity of workers	-
Afanasiev and Ponomareva [24]	fixed assets	number of employees	-
Antipov [25]	fixed assets	number of employees	+
Gafarova [26]	fixed assets	number of employees	-
Baranov [27]	fixed assets	number of employees	-

Source: Compiled by authors.

As shows information given in column 2 Table used indicators on fixed assets in 7 papers, values of investment in fixed capital in 2 papers, accumulation assets in 1 paper. In nine researches (absolute majority) as factor of employment discussed the quantity of workers occupied in the considered productions. Only in one research as such indicator presented wage. In nine studies empirical information was formed as time series. In one research was used spatial data for one year. In all the works listed in Table 1, discussed production functions similar to Cobb-Douglas functions. Thus in eight studies were not put the limits on the sum of powers. Such production functions can have increasing, constant and decreasing returns to scale.

**III. METHODOLOGY**

The object for study was small enterprises situated in each region of the Russian Federation. The valid federal law [28] has established the major criterion for enterprises classification. The law determined to consider the quantity of workers, engaged in enterprises, as this criterion. Such quantity of workers for small enterprises should not surpass 100. Herewith quantity of workers for microenterprises should not surpass 15. Consequently, from 16 to 100 person this value ranges for small enterprises (without microenterprises).

As stated in the official statistics Russian methodology, volume of production in small enterprises can be described by whole turnover, which include price of created products and revenue on the selling of bought materials.

Russian scientist Granberg [29] proposed to simplify calculation production functions quantity of factors would be not much. Such approach as whole appropriate in using Cobb-Douglas functions. We made correlation analysis, which indicated the most influence on turnover small enterprises and microenterprises of such factors: investments in fixed capital and wage of employees. Correlation analysis also presented that there is no both influence between these indicators.



It should be noted that a lot of scientists use as factor fixed capital. In our opinion more acceptable is proposal that was made by Bessonov and Tsukhlo [16] and Gavrilencov [30] on using investment in fixed capital. This proposal seems logic because as shows experience in small enterprises (and especially in microenterprises) fixed capital have incomplete use. Salary of workers in small enterprises and microenterprises is a comprehensive factor, which include not only the labor costs during making production, but also the indicators, describing particular territory (pricing, employment level, geographical and socio-economic features). Thus in the variant we proposed for construction of production function, turnover, investment in fixed capital and salary have identical dimension. The matching dimension for all indexes of production function ensure good quality approximation of empirical data during development of models. About this wrote, for example, in the paper [31].

In our study as empirical data we used spatial information, which describing turnover, investments in fixed capital and wage of employees in all enterprises, situated in each Russian region. This attitude is caused by the following. The measure for classifying small enterprises and microenterprises have modified a lot of times in recent years. The current standard is using only eleven years (from 2008 to 2018). Moreover, accounting for activity in small enterprises and microenterprises is performed once a year. Thus enterprises provide statistical bodies with statistical information annually. Therefore, during production functions development on the base of time series can be using empirical data on enterprises only for recent eleven years. According to the measure proposed by Khodasevich [32] minimum value should be sixteen for two-factor production function. Because in our case quantity of observations is equal to eleven production functions of small enterprises and microenterprises relying on time series information contradict this measure. It is important that spatial information allow excluding these problems, which is pointed in our literature review. Opportunity of applying spatial information described in paper [11]. He determined that interesting to consider factors in functions for one certain period for various territorial objects. Benefit of applying spatial information in evaluation of production functions are discussed in the article [33].

Our study consisted several stages:

- processing of empirical information. Formation of data set relying on the information describing arrays of small enterprises, small enterprises (without microenterprises) and microenterprises situated in each region of the Russian Federation. Such sets characterize amounts of this arrays enterprises turnover, investment and wage in 2018;
- linearization of information achieved at the first step, which describes separate indicators and founded parameters for small enterprises, small enterprises (without microenterprises) and microenterprises;
- generation of production functions with the use of method of least squares;
- evaluation quality of functions using coefficients of correlation and determination, tests as well as appropriate significance levels;

- testing of achieved functions on autocorrelation, heteroscedasticity and multicollinearity, and also testing of hypothesis that distributions for remains each of the regressions are functions of normal distribution;
- discussion of theoretical and empirical results, possibilities of their application.

We used in the study official statistical data of Federal State Statistics Service [34] on operation of small enterprises in 2018 in Russia. This study is based on information from 82 regions, areas, territories in the Russian Federation.

In the process of our study three production functions expressing dependence turnover of small enterprises, small enterprises (without microenterprises) and microenterprises on fixed assets investment and salary of workers in 82 Russian territories have been constructed. We developed functions, which have the characteristics similar to the proposed in [10]. Evaluation of functions based on the well-known methods [35]. Three developed production functions match to three size categories sets of enterprises situated in Russian regions. As mentioned above these sets are enterprises of various size.

#### IV. RESULT

During the calculation experiment three economic-mathematical models showing the relationship of turnover of three size categories sets of enterprises on fixed assets investment and salary of workers were developed. The dependencies presented in the paper were constructed by authors.

Production functions 1, 2, 3 presented below.

Model estimated turnover all sets of small enterprises situated in Russian regions

$$y_1(x_1, x_2) = 5.493 \times x_1^{0.180} \times x_2^{0.803}, \quad (1)$$

Where

$y_1$ : Turnover of all small enterprises in 2018, billion rubles

$x_1$ : Investments in fixed assets of all small enterprises in 2018, billion rubles

$x_2$ : Salary of workers of all small enterprises in 2018, billion rubles.

Model estimated turnover of small enterprises (without microenterprises) located in each of the regions

$$y_2(x_3, x_4) = 5.747 \times x_3^{0.140} \times x_4^{0.809}, \quad (2)$$

Where

$y_2$ : Turnover of small enterprises (without microenterprises), billions of rubles per year

$x_3$ : Investment in fixed capital of small enterprises (without microenterprises), billions of rubles per year

$x_4$ : Salary of workers of small enterprises (without microenterprises), billions of rubles per year.

Model estimated turnover of microenterprises situated in regions E-3

$$y_3(x_5, x_6) = 5.423 \times x_5^{0.172} \times x_6^{0.803} \quad (3)$$

Where

$y_3$  : Turnover of small enterprises (without microenterprises) in 2018, billion rubles

$x_5$  : Investment in fixed capital of microenterprises in region for 2018, billions of rubles

$x_6$  : Salary of workers of microenterprises of region for 2018, billions of rubles.

Evaluation of the quality for developed production functions (1)-(3) was made applying table values coefficients of correlation and determination, and also Fisher-Snedecor and Student tests. Quality evaluation is presented in table II.

Analyzing of developed production functions presented that they good approximate empirical information, characterize relationship between turnover in small enterprises and microenterprises in Russian regions and factors: investment in fixed capital and salary of workers.

**Table- II: Values estimated during calculated experiment**

Criterion of quality	Model estimated turnover		
	(1)	(2)	(3)
Determination	0.963	0.951	0.946
Correlation coefficient	0.982	0.975	0.973
Calculated value according to Fischer- Snedecor's	1041.6 67	758.49 3	696.34 3
Calculated value according to Student's test for Y -	21.112	20.380	20.74
Calculated value according to Student's test for the	5.285	4.167	4.570
Calculated value according to Student's test for the	23.261	21.224	20.206

Source: Compiled by authors.

Comparing of estimated values presented in table II with values, showed in tables for every test (described in the scientific publications) demonstrated good quality of three production functions. All correlation coefficients are more than 0.97. This indicates that dependence of turnover from factors is close to functional. Coefficients of determination are more than 0.94. These values much more than criterion (0.8) about which wrote Draper and Smith [36]. They pointed that if criterion works production functions good describe empirical information. Share of dispersion which is caused by influence of other factors which are not included in the functions describes residual from subtraction from one value of the determination coefficient. Thus we can infer that in functions (1)-(3) on the share of factors investment and salary of workers is more than 94% of all factors influence on turnover. Other factors which are not recognized in our calculations are fewer than 6%. The calculable values of all

tests are considerably greater than values in the tables. So, table value of Fisher-Snedecor test is 3.98 with a significance level of 0.05. Computed values of Fisher-Snedecor test is more than 600, i.e. higher than table value. Table value for Student test is 1.99 with a significance level of 0.05. Computed values for production functions are more than four. That is higher than table value.

Confirmation of production functions (1)-(3) with the use of Darbin-Watson test presented that there is no autocorrelation. Analogical Breusch-Pagan test presented that there is no heteroscedasticity. Variance inflation factor (VIF) test presented no multicollinearity. Namely there is no dependence among investment in fixed assets and salary of workers. In the modeling process of production functions were achieved residues relating to method of least squares. As a whole, it is proved that estimated functions (1)-(3) correspond to theoretically and econometric terms and therefore can be applied for the explanation of the activity of small enterprises and microenterprises.

## V. DISCUSSION

Developed three functions confirm the impact of the discussed factors on the turnover of small enterprises and microenterprises. Positive degrees for two factors in functions show that growth of production in these enterprises can be secured with increase in salary and in investment in capital. Values of discussing functions do not reach highest level on all range factors change. This is proved by the fact that amounts second derivative are more than zero in the total interval of changes values of factors. Consequently we can make conclusion that in all Russian regions economy is not saturated with goods and services, produced by small enterprises and microenterprises. That is why these enterprises have big reserves for further development. In other words all Russian regions can grow quantity of enterprises and amount of workers in these enterprises.

Analysis of developed functions presented that factor of salary of workers affects more on turnover than factor of investment in fixed capital.

Comparison of return to scale among various size categories of enterprises present that returns to scale for microenterprises (function 3) is 0.949. On small enterprises (without microenterprises) return to scale is more, it equals 0.983. This propose that small enterprises (without microenterprises) can ensure greater production increase while synchronous growing volume of both factors compared to microenterprises. This case is due to the given below. In microenterprises, quantity of employees is small (in middle 3-4 person). It does not allow to carry out all features as whole and to solve all tasks which enterprises have. In microenterprises every employee forced to perform a lot of functions. Such performance of functions leads on the opinion authors of study [37] to the increase of mistakes in employees work. This study points that such situation making preconditions to a relatively not high level of training, lower performance and, as a result, to decrease effectiveness of these enterprises.

Therefore there is more low competitive of microenterprises compared to small enterprises.

In order developing activities for fast growth in goods and services of sets small enterprises and microenterprises situated in Russian regions, seems logic to provide the simultaneous increase of two factors in production functions. Moreover for the territories with an extra employees population in the quantity of people (as the example in south areas in Russia), basic ways of entrepreneurship development can be is associated with growth in quantity of enterprises, including family business. In this case will grow number of employees and respectively their salary. In territories where there are low reserves of potential workers (Asia part of Russia), plans on development entrepreneurial sector must envisage growth such factor, as investment in fixed capital. As showed evaluation of three production functions (positive cross derivatives for both factors) growth in one factor enhance facilities for applying another factor. Hence increase of salary workers leads to growth in return on investment in fixed capital. On the contrary, enlarged of first factor increases use of second factor.

One of ways applying of production functions is solving such tasks as ranking territories on how effective using assets, including investment in fixed capital and salary of workers. Solving such problems based on comparing empirical (factual) volume of production of all enterprises in the territories and the value of calculated volume of production sets of enterprises forecasted on got functions. We consider that comparatively big positive amount of this value (excess of the factual turnover over evaluated one) reflects high entrepreneurial capital in the territory.

The contrastive analyzing of the empirical and factual information basing on approach discussed above discussed further:

1. Results of such comparison with the use of function (1) showed high level of entrepreneurial climate in Ivanovo, Kaliningrad oblasts, the city of Moscow and Krasnodar territory. The low level of entrepreneurial climate according to the test of efficiency of the considered factors was noted in such regions as Orenburg, Kemerovo, Amursky oblasts, Komi Republic, Khabarovsk territory. That is in these regions we have excess of the factual turnover over calculated one.

2. The contrastive analyzing of the empirical and calculated information with production function (2) presented a high level of entrepreneurial climate in Republic Mari El, the city of Moscow, Krasnodar and Altai territory. The low level of entrepreneurial climate according to the test of efficiency of the considered factors was noted in such regions as Orenburg, Kemerovo, Penza, Amur oblasts, Komi republic, Khabarovsk territory. That is in these regions we have excess of the factual turnover over calculated one.

3. The contrastive analyzing of the empirical and calculated information with production function (3) presented a high level of entrepreneurial climate in republic Tatarstan, Vologda, Kostroma, Ivanovo, Penza oblasts. The low level of entrepreneurial climate according to the test of efficiency of the considered factors was noted in such regions as Moscow, Nizhny Novgorod, Leningrad oblasts, Kamchatka territory and Sevastopol.

## VI. CONCLUSION

The research given in the article allows to draw the following conclusions:

- proposed methodology of estimation of production functions similar to Cobb-Douglas. The benefit of selecting investment in fixed capital and salary of workers and spatial information every year as factors for evaluating production functions is presented;

- two-factor models estimated in the study. These models explain relationship of volume of production on the proposed factors for sets of small enterprises and microenterprises. All evaluated production functions have good quality and useful describe the empirical information. It is proved by several tests: Fisher-Snedekor and Student;

- presented existence big reserves of increasing entrepreneurial sector and quantity of its workers in all Russian territories. Saturation with production of small enterprises and microenterprises in territories has not been reached;

- growth of one factor in production function making prerequisites in increasing of second factor. The factor of workers salary in three production functions influence on volume of production sets of enterprises more than the factor of investment in fixed capital;

- made ranking with evaluated of three production functions Russian territories on level of entrepreneurship climate. Formulated sets with high and low stage of entrepreneurship climate with dependence from using of present resources.

The empirical importance of the study can be realized in the activities of state management in entrepreneurial sector of the Russian economy, and also in pedagogical activity in the universities and other education organizations.

Methodology of the research and achieved production functions can be applied in scientific study, while revealing tasks of entrepreneurial sector.

Results of the study and tools for evaluation production functions can be applied in the studying of Russian entrepreneurship, in explanation of the development plans for this economic sector. These results can be used by governments, regional authorities and municipal management. The methodic and software that were applied in the study process can be used in making analogous studies in various countries with a considerable amount of territories.

The study we carried out ensures federal, regional governments, banks, society organizations with data on possibility development small enterprises and microenterprises in every territory. The measured production functions are making prerequisites reliable management, which enable evaluate level of effectiveness in using finance and labor costs in activity small enterprises (microenterprises) in the Russian Federation and its territories.

The results of our research are of interest for authority bodies and organizations associated with provision and making help to small enterprises and microenterprises.

The empirical importance of the research is the opportunity of applying the results achieved during justifying requirement of resources and observing the entrepreneurial climate in Russian territories and municipal areas. Production functions can be applied in solving problems in monitoring effectiveness flows of investment and salary of workers, on the basis of approach presented in the end of the part "Discussion of the results modeling" of our paper. That is, they can be applied to estimate the level of effectiveness both of the debated factors production functions. Moreover basic attention must be dedicated to the identified disbalance between factor values and also between turnover and these factors. Production functions are of interest in justification requirements in financial and labor resources needed for small enterprises and microenterprises. Including in proving plans and programs for the following entrepreneurial sector in the Russian territories. Must be mentioned, that obtained including on the basis of self-employment with the use of financial resources provided in the circle of programs developing entrepreneurship. Which presented according to the described strategy.

Our study has scientific and practical significance outcomes of the research to provide the realization of Russian strategy for the growth of entrepreneurship [38]. The social importance of the study is associated with involvement new entrepreneur in creation their own business

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