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Modeling the activities of small enterprises located in the russian regions

Iuliia Pinkovetskaia*

Lyudmila Kryukova**

ABSTRACT

The aim of the study was to assess the two-factor production function describing the dependence of the turnover of small enterprises in the regions on the wages of workers and investments in fixed assets. The study was based on the empirical spatial data characterizing the activities of small enterprises, including microenterprises. We used the official statistical information on 82 Russian regions in 2017. The study made it possible to prove the high quality of the approximation of the initial data obtained by the two-factor production function. The results of the study, namely, new knowledge for evaluating the production activities of small enterprises, have scientific and practical significance. They can be used in new science research, monitoring the entrepreneurial climate, determining resource requirements, justifying small business development plans and programs.

KEYWORDS: production function, small enterprises, investments in fixed capital, wages, regions of russia

* Associate professor, PhD. Ulyanovsk State University.
Correo: pinkovetskaia@gmail
** Associate professor, PhD. Penza State University.

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Modelización de las actividades de pequeñas empresas ubicadas en las regiones rusas

RESUMEN

El objetivo del estudio fue evaluar la función de producción de dos factores que describen la dependencia del volumen de negocios de las pequeñas empresas en las regiones Rusaas, con respecto a los salarios de los trabajadores y las inversiones en activos fijos. El estudio se basó en los datos espaciales empíricos que caracterizan las actividades de las pequeñas empresas, incluidas las microempresas. Se empleó la información estadística oficial de 82 regiones rusas en 2017. El estudio permitió demostrar la alta calidad de la aproximación de los datos iniciales obtenidos por la función de producción de los factores. Los resultados del estudio son los siguientes: estos resultados tienen importancia científica y práctica, pues sirven para evaluar las actividades de producción de las pequeñas empresas; pueden utilizarse en nuevas investigaciones científicas, monitorear el clima empresarial, determinar los requisitos de recursos, justificar planes y programas de desarrollo de pequeñas empresas.

PALABRAS CLAVE: función de producción, pequeñas empresas, inversiones en capital fijo, salarios, regiones de Rusia.

МОДЕЛИРОВАНИЕ ДЕЯТЕЛЬНОСТИ МАЛЫХ ПРЕДПРИЯТИЙ, РАСПОЛОЖЕННЫХ В РЕГИОНАХ РОССИИ

Аннотация

Целью исследования являлась оценка двухфакторной производственной функции, описывающей зависимость оборота малых предприятий в регионах от заработной платы работников и инвестиций в основной капитал. Исследование проводилось на основе эмпирических пространственных данных, характеризующих деятельность малых предприятий, в том числе микропредприятий. Мы использовали официальную статистическую информацию по 82 регионам России в 2017 году. Исследование позволило доказать высокое качество аппроксимации исходных данных с помощью двухфакторной производственной функции. Результаты исследования, а именно новые знания для оценки производственной деятельности малых предприятий имеют научное и практическое значение. Они могут быть использованы в новых научных исследованиях, мониторинге предпринимательского климата, определении потребностей в ресурсах, обосновании планов и программ развития малого бизнеса.

Ключевые слова производственная функция, малые предприятия, инвестиции в основной капитал, заработная плата, регионы России

Introduction

At the end of the twentieth century small entrepreneurship significantly increased its share in the gross domestic product and the number of employees in most developed countries (Wennekers *et al*, 2002; Brock *et al*, 1989; Action Plan to Promote Entrepreneurship and Competitiveness, 1999). Small enterprises act as the main sources of economic growth, the creation of new markets, and the satisfaction of the need of the population for jobs (Van Praag *et al,* 2007; Feldman *et al*, 2011). As the accumulated experience shows (Mosina, 2016; Safiullin *et al*, 2016; Chepurenko, 2017; Decker *et al*, 2014), it is the entrepreneurial sector that is the main driver of regional development, especially in underdeveloped areas, and creates conditions for economic restructuring. Therefore, small business in recent years has become an essential element of the economic policy of both developed and developing countries.

At present numerous small businesses operate in the Russian business sector. In 2017 their number exceeded 2,755 thousand, and 11,986 thousand employees worked in them. At the same time, the share of small enterprises is less than 20% of the gross domestic product and the number of employees all enterprises and organizations in Russia. This indicates that small enterprises have not yet received much development in Russia. For comparison, it can be noted that small enterprises in the European Union provide jobs for about 67% of the working population and produce 58% of the gross domestic product (Development of small and medium entrepreneurship, 2015).

Thus, in Russia at present there is an urgent need for the accelerated development of small enterprises. The development of the entrepreneurial sector of the national economy requires an understanding of the factors that influence the activities of small enterprises and their production volumes. One of the most pressing problems is to determine the growth reserves of such enterprises in each of the regions. Justification of existing reserves, as well as the resources necessary for the effective functioning of small enterprises, can be based on such mathematical models as production functions. Russian and foreign experience has shown the possibility of widespread use of production functions in economic analysis and management. Production functions are economic-mathematical models of production processes and quantitatively express a steady natural relationship between the factors describing the capital and labor costs, and the indicator characterizing the volume of production.

On this basis, the purpose of the study presented in this article was to assess the factors that influence the turnover of small enterprises using the production function.

1. Literature review

The first calculations of production functions were performed by Cobb and Douglas and presented by them in (Cobb *et al,* 1928). The theoretical foundations, as well as the development of the theory and practice of constructing such functions, are described in the article by Douglas (1984). The important value in the development of the theory of production functions was Durant (1937) offer, namely, not to impose restrictions on the returns from the scale of production.

In Russia, the theoretical aspects of the study and use of production functions are reflected in many works, among which the most interesting are (Bessonov *et al,* 2002; Kleiner, 1986). Production functions underlie modeling of the activities of various economic and economic objects and systems: from individual enterprises and organizations to regions, industries and the economy as a whole.

Currently, the most widespread are power functions. The absolute majority of the studies have confirmed the feasibility of using power production functions that differ in the objects under study, the types of resulting indicators and factors, the types of initial empirical data, and the presence or absence of restrictions on the sum of the degree indicators. Table 1 contains the examples of the Russian studies, the results of which were published in 2016-2018. It provides the analysis of the established methods for evaluating such production functions.

Table no. 1 – Characteristics of the Russian Research

Authors	Capital factor	Labor factor	Volume production	Baseline data	Limit on the impact of production scale	Area under study
1	2	3	4	5	6	7
Alferova *et al* (2018)	fixed assets	labor costs	Output of products, goods, services	temporary rows	no	Perm region
Kamaletdinov *et al* (2018)	fixed assets	labor productivity	Tax revenues by region	spatial data	no	regions of Russia
Sokol *et al* (2017)	fixed investment	labor costs	GRP	temporary rows	yes	Ugra
Nikonorov (2017)	fixed assets	employment rate	retail volume	temporary rows	no	Russian trade sector
Adamadziev *et al* (2017)	fixed assets	employment rate	GRP	spatial data	yes	regions of Russia
Sadovin *et al* (2017)	fixed assets	employment rate	GRP	time series	no	regions of Russia
Pshenichnikova *et al* (2017)	fixed assets	employment rate	GDP	time series	no	Russia
Arzhenovsky *et al* (2016)	fixed assets	employment rate	GRP	time series	yes	Rostov region
Nosov *et al* (2016)	fixed assets	employment rate	GDP	time series	no	BRICS countries
Adamadziev *et al* (2016)	fixed investment	employment rate	GRP	spatial data	no	regions of Russia

Source: The table was developed by the authors.

The information given in Table 1 shows that in most cases the objects of study are the economies of the Russian regions (four cases) and specific regions (three cases). In addition, objects under study were the Russian economy as a whole, the BRICS countries, as well as the totality of trade enterprises located in Russia. The resulting factor of the production functions were the gross regional product (GRP) by region – six times, gross domestic product (GDP) by country - twice, and also tax revenues

by region and retail volume once. As the factors describing the capital, the fixed assets of enterprises and organizations are considered in 8 papers, the flows of investments in fixed capital – in 2 papers. As the factors describing the labor costs the number of workers employed in the production processes is used in the absolute majority of papers (7), the 2 papers point to labor costs and 1 paper points to labor productivity. As the baseline data time series were presented in 7 studies, while 3 papers used spatial data for one year. In all the works, listed in Table 1, the authors considered power production functions, while in seven cases no restrictions were imposed on the sum of the exponents. That is, the production functions were evaluated, in which increasing, constant and decreasing returns to scale were allowed.

The research based on production functions according to aggregates of small enterprises has received certain development in many countries. In most cases, the factors that determine the volume of production are capital costs (the cost of all machinery, equipment and buildings) and labor costs. As labor input, scientific research discusses various indicators. So in the works (Bohórquez *et al,* 2008; Husain *et al,* 2016) for the description of labor costs they use the number of permanent employees. And the book (Sage *et al,* 2011) considers such an indicator as the total number of man-hours worked during the year. In most works observations are based on time series. Thus, the article (Khatun *et al,* 2016) proved the influence of the number of workers and fixed capital on the real GDP for such Asian countries as Bangladesh, India, China, Malaysia and Thailand, based on the use of the time series for the years 1990-2014. The paper (Batool *et al,* 2013) presents the analysis of the impact of these indicators on the production of small and medium-sized enterprises in Pakistan. It should be noted that the studies based on the assessment of production functions, describing the activities of aggregates of small enterprises in Russia have not received any significant development. At the same time the work (Pinkovetskaia, 2014) is possibly worth mentioning, in which the method of developing production functions according to the data of aggregates of small and medium enterprises in the regions was considered in detail.

2. Methodical approach to the evaluation of production functions

As an object of the study we considered small enterprises located in each of the regions of Russia. The current law On the development of small and medium-sized businesses in the Russian Federation of 24.07.2007 No. 209-FL established the main criterion for classifying business entities as small enterprises. The number of employees is considered as this criterion, which for small enterprises should not exceed 100 people. In our research we studied the patterns characteristic of aggregates of small enterprises located in each of the regions.

The study showed that in the process of evaluating production functions, a number

of problems arise, without their overcoming adequate results cannot be obtained. These issues are discussed further. The use of the baseline data for ten years or more (time series) is complicated by the fact that it is necessary to take into account the inflation processes that have taken place. In addition, it is necessary to proceed from the assumption that the conditions of functioning of the object of study during the considered time interval will be identical or, at least, undergo little change, which in practice is not always performed. Time series are often limited in length, especially since the dynamics of changes in indicators are experiencing significant fluctuations due to the crisis in the economy. Particularly great influence of these trends in the process of evaluation of functions occurs when there are restrictions on the sum of the exponents with factors, that is, with constant returns from scale. When used as the factor describing the cost of capital, the values of fixed assets, the main problem is the reliability of information on the share of fixed assets of the economic system under consideration that is actually used in production processes. The assumption of the full use of fixed assets does not always correspond to their actual load. A similar situation is observed regarding the second factor. The number of workers directly involved in production processes does not always coincide with actual labor costs, since the workers are often not employed the whole working day (working week). This leads to erroneous indicators in the evaluation of labor factors.

In the Russian statistics the following approach has been adopted, according to which it is customary to characterize the volume of products produced by small enterprises by total turnover, which consists not only of own-produced goods, but also of the proceeds from the sale of goods purchased on the side. Taking into account the tasks in the process of evaluating production functions, in the process of research we considered only that part of the turnover of small enterprises, which is associated with the cost of own-produced goods, as well as the work and services performed by their own efforts. This methodical approach was not previously used in the Russian studies.

Taking into account the conducted analysis we considered the investments in fixed assets and wages of workers as the factors of the production function. The correlation analysis showed that these factors have the greatest impact on the turnover of small enterprises. At the same time, there is no interconnection between them (collinearity). It should be noted that the investment flow provides more acceptable results in comparison with such a factor as fixed assets. Such a conclusion was made in the works of Bessonov and Tsukhlo (2002), Gavrilenkov (2000), based on the incomplete use of fixed assets in small enterprises, which we indicated earlier. The wages of workers employed in small enterprises is a comprehensive indicator that takes into account not only the labor costs of producing products, but also the characteristics of a particular region (price level, employment, and other socio-economic aspects). In addition, the use of wages of workers as a factor ensures the same dimensionality of all indicators of the production function. The same dimension of all indicators of the production function, as shown in article (Felipe *et al,* 2012), provides high quality construction of the corresponding models.

In our study we used the spatial data characterizing the factors under consideration and the resulting indicators for the totality of all small businesses located in each of the regions of Russia. This approach is due to the following. The criteria for classifying enterprises as small enterprises have changed several times in recent years. The current criteria have been used since 2008. Accounting in small businesses is carried out once a year, respectively, the data are submitted annually to statistical agencies. Therefore, the simulation of indicators characterizing the activities of such enterprises using time series is possible only for 10 years (from 2008 to 2017). Accordingly, the number of observations is nine, which is less than the minimum allowable value, which, in accordance with the criterion proposed in (Khodasevich, 2018), should be at least 16 for the two-factor function criterion. It should be noted that spatial data allows you to get away from the problems that are characteristic of time series, as discussed in the literature review. Another founder of the theory of production functions, P. Douglas, pointed out that it is interesting to consider many simultaneously conducting activities of economic entities for one definite period of time. The advantages of using spatial data in evaluating production functions are described in detail in (Charoenrat *et al,* 2013).

Our study included the following steps:

- Collection and processing of primary statistical data on turnover, investments in fixed assets and wages of a set of small enterprises located in each region;

- Formation of information arrays of summary indicators;

- Linearization of the data obtained at the first stage, which characterize independent factors and the resulting variable;

- Development of production functions using the method of least squares.

The evaluation of the quality of functions was carried out according to the accepted methods using correlation and determination coefficients, Fisher-Snedecor and Student's tests, as well as the corresponding levels of significance. The developed function was checked for autocorrelation, heteroscedasticity and multicollinearity, and whether the distribution of residuals by regression is normally distributed with the zero mean value.

The study used the official statistics of the Federal Service for State Statistics (Federal service of state statistic, 2018) regarding the activities of small business in Russia for the year 2017. The study is based on the information on 82 regions of Russia. Thus, the number of empirical observations in the process of modeling exceeded the optimal observation value of 52 proposed by Harris (1985). Some characteristics of the performance of the aggregates indicators of small enterprises located in the Russian regions are given in Table 2.

Table no. 2 – Small business activity indicators for the year 2017, billion rubles

Indicators	Minimum value	Maximum value	Average value	Median value	Average quadratic deviation
The turnover aggregate of small enterprises in the region	4.365	5638.141	245.548	113.857	642.240
Fixed investment	0.092	85.669	12.177	7.967	14.545
Wages of small business employees	1.132	1470.161	70.529	33.642	171.979

Source: The table based on statistics was developed by the authors.

In the course of our research, we worked out the production function, reflecting the dependence of the turnover of small enterprises on investments in fixed assets and wages of workers in all regions of Russia. The parameters of the production function were determined by means of the regression analysis methodology (Pindyck *et al,* 2013). As we have already noted, the estimated function describes the activities of the aggregates of all small enterprises located in each of the regions of Russia.

3. The results of economic and mathematical modeling

The developed function describing the dependence of the turnover totality of all small enterprises located in each of the regions is given below:

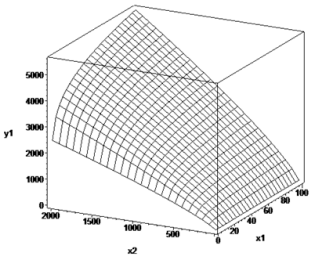
$$y_1(x_1, x_2) = 4.512 \times x_1^{0.177} \times x_2^{0.829}, \quad (1)$$

where y_1 - turnover of all small enterprises located in a specific region of Russia for the year, billion rubles;

x_1 - investments in the fixed capital of all small enterprises of this region for the year, billion rubles;

x_2 - salary of employees of all small enterprises in this region for the year, billion rubles.

A graphical interpretation of this function is presented in Figure 1.



Source: Developed by the authors

Figure no. 1 The production function reflecting the dependence of the turnover of small enterprises on investments in fixed capital and wages of workers

The figure shows that the growth of wages and investments in fixed assets leads to an increase in the turnover of small enterprises in the regions. A logical analysis of the production function showed that it adequately describes the turnover of small enterprises throughout the entire range of factors.

The analysis of the quality of the function obtained is given in Table 3. It presents the calculated values of the correlation and determination coefficients, The Fisher-Snedecor and Student's tests (column 2), as well as the significance of the Fisher-Snedecor's test and p-values for the Student's test (column 3).

Table no. 3 – Calculated values for coefficients and tests

Quality indicators	Calculated values	**Significance and p-values**
1	2	3
Coefficient of determination	0.965	-
Correlation coefficient	0.982	-
Standard error	0.239	-
The estimated value of the test Fisher-Snedekor	1076.687	less than 0.001
Estimated value of the Student's test for Y - intersection	19.059	less than 0.001
Estimated value of the Student's test for the first factor	6.049	less than 0.001
Estimated value of the Student's test for the second factor	27.221	less than 0.001

Source: The table was developed by the authors.

The comparison of the calculated values given in Table 3 with the values of the tests presented in the literature showed that the production function (1) is of high quality. The correlation coefficient is close to unity, which indicates the proximity to the functional relationship between the volume of the production and the two factors considered. According to Draper and Smith (1998), the functions are of good quality and successfully describe the empirical data when the coefficients of determination exceed 0.8. For the function (1) this coefficient is substantially greater than this criterion and amounts to 0.982. The difference between the unit and the coefficient of determination characterizes the proportion of dispersion, which is due to the influence of other factors outside the function. This allows us to conclude that the function (1) explains 96.5% of the variation of the dependent variables. Accordingly, other factors (which are not taken into consideration here) account for no more than 3.5%. The calculated statistics value is significantly higher than the Table value of the Fisher-Snedecor's test, which is 3.98 at a significance level of 0.05. All calculated values of the Student's test are greater than the Table value, which at a level of 0.05 is 1.99. Thus, the function (1) well approximates empirical data.

The estimated value of the level of significance for the Fisher-Snedekor's test is less than 0.001 (column 3 of Table 3). This suggests that there is indeed a close correlation between the turnover of small enterprises by region and factors such as investments in the fixed capital of these enterprises and the wages of their employees. All p-values are less than 0.001, that is, with high confidence (99.9%), the coefficient of the developed function and the exponents in this regression model are statistically significant.

Checking the function (1) by the Darbin-Watson's test showed the absence of autocorrelation, while using the Breush-Pagan's test - the absence of heteroscedasticity. The level of collinearity of the independent variables was controlled by the criterion of the dispersion factors of inflation (VIF).

In the process of approximation of the source data by the method of least squares the residues were obtained, which show the deviations of the calculated values from the source data. The distribution of these residues in the production function (1) was checked on the basis of an assessment of the histogram graph, the normal distribution function and normality tests. The study confirmed the normal distribution described by this function.

In general, it can be concluded that the developed function (1) fully meets the econometric requirements and therefore can be used to describe the dependence of the turnover of aggregates of small enterprises in the regions of Russia on the investments in fixed capital and wages of employees of these enterprises.

4. Discussion of the results

The developed production function (1) proves the presence of the influence of the factors under consideration on the turnover of enterprises belonging to the small business in the regions of Russia. The values of the degrees for both factors in the function (1) are positive, therefore, it can be stated that the promotion of small business development can be provided by an increase in wage costs and growth in the investments in fixed capital. The production function (1) for the factors (Table 1) does not reach its maximum. This is confirmed by the fact that the values of the marginal returns for both factors are positive on the considered ranges of values of the factors. Consequently, it can be concluded that the economy of the regions of Russia has not reached the saturation by the products of small enterprises, and 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.

The sum of the values of the exponents in the function (1) is greater than one, which indicates an increasing returns from scale. A similar trend has been noted in the Asian countries (Khatun *et al,* 2016). With the increase of both factors (investment in fixed assets and wages of employees) the growth in production volumes goes faster than the growth of factors. For example, with the growth of both factors in the function (1) by 10%, the volume of production increases by 10.06%. The

accelerated increase in production with the growth of factors is of great economic and social importance. For a rapid increase in the production of small enterprises in the Russian regions it is advisable to ensure the simultaneous growth of both these factors. This will increase returns from scale. It should be noted that for regions with a surplus of able-bodied population (on the example of the republics of the North Caucasus) the main direction of development of entrepreneurship is associated with an increase in employment and the creation of a family business. In regions where there is a shortage of potential workers (Siberia and the Far East) the main direction of increasing production volumes is associated with an increase in investment in fixed assets. Cross derivatives of the production function (1) for each of the two factors are positive for all values of the range of variation of these factors, so an increase in one of the factors improves the conditions for using another factor. That is, the growth of wages of workers increases the return on investment in fixed capital. And, conversely, with an increase in investment in fixed assets, the level of wage utilization increases. The second derivatives of all isoquants are positive. The level of convexity decreases with increasing turnover, which indicates an increase in the elasticity of substituting factors: with the growth of production volumes in small enterprises, the possibility of replacing one factor with another one increases. The wage factor affects the turnover to a greater degree than the factor of investment in fixed assets.

The use of the production function (1) is possible when solving such an urgent problem as the compilation of regional rankings based on the efficiency of using such resources as investments in fixed capital and wages of employees of small enterprises. In this case a comparative analysis of the actual turnover of all small enterprises in the region and the value of the turnover predicted on the basis of the production function in the same region can be used. In our opinion, a relatively large positive value of this magnitude (that is, the excess of the actual turnover over the calculated turnover) indicates a good business climate in the relevant region. And, accordingly, a large negative value of this indicator allows us to conclude that there are problems with the business climate in the respective region.

A comparative analysis of the empirical data used in the development of the production function (1) and the predicted values for the same function showed a high level of business climate in the Ivanovo and Kaliningrad regions, the city of Moscow, and the Krasnodar Territory. The low level of entrepreneurial climate by the criterion of efficiency of using the factors under consideration occurred in 2017 in such regions as the Orenburg, Kemerovo and Amur regions, the Komi Republic, and the Khabarovsk Territory.

Conclusions

The conducted research have scientific and practical significance.
The scientific significance of the research is as follows:

- we reviewed the methodological aspects of the evaluation of production functions. It is shown that in the process of evaluating production functions a number

of problems arise, without their overcoming adequate results cannot be obtained. These problems include the use of fixed assets as a factor of capital and the number of workers employed in production processes as a factor of labor, as well as the data generated in the form of time series. We showed the advantages of choosing as factors when evaluating the production function of aggregates of small enterprises in the regions of the flow of investment and wages of workers and spatial data for one year;

- in the process of research a two-factor production function was developed, analogous to the Cobb-Douglas function. This function describes the dependence of the turnover of small enterprises on the factors considered in the regions. Using a series of tests the high quality of the developed production function and a good approximation of the initial data were confirmed;

- the production function has proved that there are significant reserves for the further development of small enterprises in Russia, including all Russian regions, that is, it has been shown that the saturation of regional markets with goods and services of small enterprises has not been achieved. Increasing one of the factors of the production function improves the conditions for using another factor. With the growth of production volumes in small enterprises, the possibility of replacing one factor by another increases. The factor of wages of workers in the production function affects the turnover to a greater degree than the factor of investment in fixed assets. We proved that small enterprises production had an increasing return from scale in the regions;

- using the production function, the regions of Russia were identified with high and low levels of efficiency in the use of available resources (business climate).

The practical significance of the research can be implemented in the activities of the government, in the entrepreneurial sector of the national economy, as well as in educational activities. The obtained new knowledge can be used in scientific research, in the educational process in the preparation of bachelors and masters, as well as training specialists in small business problems.

The methodical approach proposed in the article for evaluating the production function describing the activities of aggregates of small enterprises in the regions can be used in scientific research on the problems of entrepreneurship, as well as the substantiation of development programs for this sector of the economy at the federal and regional levels. The methodology and tools that were used in the research process can be applied in similar studies in countries with a significant number of territorial (administrative) units.

The study provides the government, regional authorities and other administrative structures with the information on possible ways to increase the production of small enterprises. The developed production function is an effective management tool that allows you to assess the level of use of financial and labor resources of small enterprises in Russia and specific regions. The results of the work can be used in the current activities of state, municipal and public organizations related to the regulation

and support of small business, including adjusting their actions based on scientific data.

The practical significance of the study lies in the possibility of using the results obtained to justify resources and monitor the entrepreneurial climate. The results of the study can be used by state and regional authorities to monitor the effectiveness of investments in fixed capital and labor resources. That is, to assess the level of effectiveness of each of the factors discussed, as well as the revealed imbalance in the values of the factors for each of the regions. The function can be used to justify investments in fixed capital and labor resources needs, including the implementation of the Federal Strategy for the Development of Small and Medium Enterprises in the Russian Federation for the period up to 2030.

Further studies are related to the assessment of production functions for sets of small enterprises that are specialized in various types of economic activity, as well as located in the municipalities of specific regions.

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