



Differentiation of small and medium enterprises based on headcount

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ABSTRACT

In order to solve managerial tasks related to the further development of small and medium-sized enterprises (SMEs), to provide them with the necessary assistance and support, as well as to improve their operations, there must be information on how SMEs are broken down in terms of headcount. The purpose of this study was to analyze the patterns and trends characterizing the differentiation of enterprises with different headcounts, as well as employees working in these enterprises. Official statistical information was used as input data. This study was based on an analysis of how much the enterprises with a particular headcount account for in the total number of enterprises and how much the employees working in such enterprises account for in the total workforce. It was demonstrated that the high quality of input data approximation is ensured by power and exponential monotonically decreasing functions. It was discovered that the segment of enterprises with a headcount of up to 250 people is predominated by those where there are maximum 5 employees. It was also discovered that during the period from 2010 to 2013 the proportion of such enterprises increased.

Keywords: small enterprises, medium(-sized) enterprises, headcount differentiation, regression models, power function, exponential function.



INTRODUCTION

Contemporary small and medium businesses constitute a complex system. First of all, it is an array of a large number of independent economic entities, each of which on its own sets its goals and objectives based on a particular situation, and is an active participant in socioeconomic processes. Given that business entities start and cease to operate naturally, they should be considered as self-organizing and dynamic economic entities. Some entrepreneurs deal with tasks related to the self-fulfillment of a creative individual, as well as of the team as a whole. They carry out risky activities aimed at generating consumer demand and increasing the overall level of supply, as well as producing new economic resources and goods.

As shown by studies [13, 15, 22], small and medium businesses act as the key driver for increasing the sustainability and growth of national economies. They ensure the creation of new jobs and the reduction of social tensions, as noted in articles [18, 19]. They also reduce the impact of crises and shocks for economies. A case in point is the recent economic downturn, when it was SMEs that retained their position as the basis of EU economy, accounting for more than 99.8% of all enterprises, 67% of total employment and 57.5% of gross added value [27, 28]. In addition, the role of entrepreneurship in overcoming the unstable economic situation in recent years is described in the article of Simon-Moya et al [26, 29].

Studies of the structure of small and medium businesses have become widespread in foreign countries. The most interesting are the following works. In the conference materials [23] it was examined how SMEs are broken down by categories of size in terms of headcount. The weights of each size category were considered for the following “greater regions”: East Asia, Latin America, Africa, Central Asia, South Asia, Eastern Europe, Middle East. Data on the member countries of the Organization for Economic Cooperation and Development (OECD) were presented separately. Rembeci presented an analysis of the size based breakdown of enterprises operating in the European Union and Albania [24]. It showed how much both SMEs and large enterprises account for in the total number of enterprises, the total workforce and the total added value. Senner et al. [25] identified the current structure of SMEs, their output and headcount in Turkey.

By 2013, there were more than 4.5 million small and medium-sized enterprises (SMEs) in Russia, with the total number of workers employed by them exceeding 19 million people [12]. Contemporary small and medium businesses constitute a complex system. First of all, it is an array of a large number of independent economic entities, each of which on its own sets its goals and objectives based on a particular situation, and is an active participant in socioeconomic processes. Given that business entities start and cease to operate naturally, they should be considered as self-organizing and dynamic economic entities. Some entrepreneurs deal with tasks related to the self-fulfillment of a creative individual person, as well as the team as a whole. They carry out risky activities aimed at generating consumer demand and increasing the overall level of supply, as well as producing new economic resources and goods.

The criteria for classifying economic entities in Russia as small and medium-sized enterprises are defined in Federal law No. 209-FZ "On the development of small and



medium-sized enterprises in the Russian Federation" dated July 24, 2007 [10]. It sets the number of employees (for small businesses – up to 100 people, and for medium-sized enterprises – from 101 to 250 people). In addition, the following criteria are applied: how much of an enterprise is owned by federal and municipal governments and what is the amount of its revenue (i.e. proceeds from the sale of goods, works, services), as well as how large is the carrying value of its assets. The government sets maximum revenue from the sale of goods (works, services), as well as the carrying value of fixed assets of small and medium-sized enterprises, as required. An essential feature of these enterprises is that they must be included in the state register of legal entities.

The headcount of a small and medium-sized enterprise directly depends on the technology of its production processes, the types of its products (services), its financial and economic performance, as well as the structure and methods of its management. At the same time, the number of workers employed in enterprises acts as an important socioeconomic factor that determines the standard of living of the population both in local and federal municipalities. In order to solve managerial tasks related to the further development of enterprises and to provide them with the necessary assistance and support [9], as well as to improve their operations, there must be information on how they are currently differentiated in terms of headcount. Namely, which enterprises are prevalent headcount-wise (i.e. occur more frequently) and in which enterprises there are more workers. Therefore, the study of patterns and trends as to how enterprises are broken down in terms of number and headcount is relevant.

METHODS OF RESEARCH AND DATA

The purpose of this study was to analyze the patterns and trends characterizing the differentiation of enterprises with different headcounts, as well as of the employees working there.

The following tasks were solved during this study:

- an array of initial data, describing the indicators that characterize the number of enterprises with different headcounts and the number of employees in such enterprises, was created;
- the initial data was processed and an information base was created, which describes the number of enterprises with different headcount, as well as the number of employees working at these enterprises in a number of federal municipalities;
- representative samples from the general populations, which characterize the total number of enterprises and the total number of employees working there, were validated;
- a computational experiment was conducted and regression models were developed;
- the initial data approximation quality was checked using accepted criteria;
- the developed models were analyzed and patterns characterizing the breakdown of enterprises and their headcount were identified;
- a comparative analysis was conducted with regard to the results of the studies performed using the data for 2010 and 2013.

It should be noted that one of the authors has previously conducted a pilot study,



the results of which are presented in [8]. Due to the significant changes in the country's economy in recent years, it is interesting to assess the current breakdown of enterprises in terms of number and headcount according to the data for 2013, as well as to compare the patterns characteristic for 2010 and 2013.

As a hypothesis put forward in the course of this study, it was considered whether it was possible to describe dependence of how much the enterprises with a particular headcount account for in the total number of enterprises, as well as how much the employees working at such enterprises account for in the total workforce, on such a factor as the headcount. Such hypothesis was tested based on the development of economic and mathematical models which are regression functions.

Regression functions are models that reflect economic processes and phenomena. They describe stable natural correlations between the indicators characterizing such processes and phenomena. These functions underpin the modeling of activities carried out by a wide variety of economic entities and systems, ranging from individual enterprises and organizations, to regions, industries and the economy as a whole [16].

In order for the quality of regression models and the quality of our regression analysis to be determined, the following procedures should be performed.

At first, the coefficient of determination is estimated, indicating what percentage of the function variation is due to an effect from the factors given in it. However, the difference between the unit and the value of such determination coefficient is due to an effect from other factors not taken into account in the developed factors function.

Then the significance of the developed model function is checked. This check is based on a statistical evaluation of the resulting equation. Such evaluation begins with a Fisher-Snedecor test, which is aimed at determining the ability of studied factors to explain the significant part of a function fluctuation. If the test result is significant, then there is a correlation between the values of the function and the factors. That means that one should proceed to study and explain it. If the results of such check suggest that such correlation is insignificant, a further investigation of the developed function is impractical. It should be noted that this check can be performed in two ways. The first of them is carried out by comparing the test's calculated value with the table index used for the respective level of significance. If the calculated value is less than in the table, it can be argued that the developed function is statistically significant. The second method is based on considering the calculated significance level corresponding to Fisher-Snedecor test. If a value of the significance level exceeds 0.05, then the result should be interpreted as insignificant (95 percent probability). In the case when its value is under 0.05, then the function is significant with a probability of 95%. If a value of the significance level is less than 0.01, then the result is highly significant and the developed function is reliable to 99 %.

The significance of regression coefficients is checked using Student's t-test. It is also done by comparing the calculated values of this test with the table or by analyzing the significance level for each of the factors and the function coefficient.

Given the lack of statistical data on the number of enterprises grouped based on headcount in all Russian federal municipalities, the study was conducted on the basis of



information describing a sample from the general populations which characterize the total number of enterprises and the total number of employees working there.

The possibility of using such samples was based on the generally accepted methodological approach detailed in sources [4, 6]. The statistical information describing the results of a pilot work aimed at forming business demography indicators was used as the initial data. These works were performed according to the data for 2013 in territorial bodies of the state statistics for the Republic of Tatarstan, Perm Territory, Astrakhan, Belgorod, Vologda, Novosibirsk and Sverdlovsk regions and are published on the official site of Rosstat (Russian State Statistics Agency) [11].

The information published on the website describes the number of active enterprises and their headcount as broken down by groups. The groups are formed based on the headcount in particular enterprises. Active enterprises are those where the average headcount and income exceeded zero values for the previous calendar year. The small and medium-sized enterprises in question operate in all types of industries and sectors, with the exception of public administration. In addition, such enterprises do not include those owned by federal and municipal governments, NGOs and religious organizations, as well as consumer cooperatives.

The study analyzed data on SMEs with a headcount from 1 to 250. Such enterprises constitute an absolute majority in each of the country's federal municipalities in question. In 2013 larger enterprises accounted for 1.0% in the Republic of Tatarstan, 0.7% in the Perm territory, 0.8% in the Astrakhan region, 1.5% in the Belgorod region, 1% in the Vologda region, 0.8% in the Novosibirsk region and 0.7% in the Sverdlovsk region. That is to say, on average, no more than 1%. It should be noted that such large enterprises (with more than 250 employees) are individual phenomena and their number in a particular federal municipality depends on the natural and climatic conditions, the availability of mineral and other resources (including labor and energy), as well as the historical features of a given region.

The sizes of samples [6] ensuring that the conclusions made based on them are representational were validated according to the following formula:

$$n = \frac{1}{\frac{h^2}{t^2 \times m(1-m)} + \frac{1}{N}}, \quad (1)$$

where n – sample size

N – general population size;

t – coefficient determined by the level of confidence;

m – the proportion in a general population is taken to be 0.5 (with the maximum sample size);

h – the value of an error margin (tolerance in proportions).

RESULTS OF THE STUDY

The study of patterns shown in the breakdown of enterprises in terms of number and headcount based on the size of an enterprise (the number of employees working there)



was based on an analysis of how much enterprises with a particular headcount account for in the total number of small and medium-sized enterprises, as well as of how much the employees working there account for in the total workforce. In order to be able to carry out such analysis based on the initial data, it was necessary to create an information base for the development of economic and mathematical models, including the values of resulting variables, i.e. how much enterprises with a particular headcount account for in the total number of enterprises and how much the employees working there account for in the total workforce. When such information base was being created, each value of the weight corresponded to the value of an independent variable (factor), i.e. the size of an enterprise.

The regression models were developed using the relevant methods detailed in sources [17, 5]. In doing so, different model specifications were considered, for each of which on the basis of a correlation analysis it was determined whether there was a correlation between the factor (number of enterprises) and the variables studied. The structure of such correlation and its density were also determined.

The best models were selected using such criteria as correlation and determination coefficients, as well as Fisher-Snedecor test and Student's t-test. In addition, a logical analysis of the initial data approximation quality was conducted throughout the change in values of the average headcount in the enterprises in question (from 1 to 250 people).

The relevant calculations (computational experiment) were carried out by the author using "Microsoft Excel" and "Mathcad" programs.

During the first stage, basic statistics were collected and processed. As already mentioned, we used the business demography figures for 2013, which characterize the breakdown of enterprises in terms of number and headcount in seven federal municipalities with a developed business sector: Sverdlovsk, Novosibirsk, Perm, Belgorod, Vologda, Astrakhan regions and the Republic of Tatarstan.

It should be noted that these federal municipalities belong to different federal districts, different climatic zones and have different socioeconomic conditions, which increases the reliability of our studies. As an example, Table 1 presents data showing the number of enterprises and their employees (for enterprises located in the Perm region and having a headcount of up to 250 in 2013).

Table 1

Initial data on Perm region's enterprises

Headcount per enterprise	As broken down by enterprise groups	
	The number of enterprises	The number of employees
1	2	3
2-4	6184	17468
5-9	4124	26789
10-15	2099	25425
15-21	886	15885
21-50	2231	71953



51-100	1034	72791
101-200	283	40341
201-250	70	15760
Total	37094	306595

Source: according to the materials published by Russian Federal Service of State Statistics.

On the basis of similar initial data for the other six federal municipalities, a summary table was developed for all enterprises included in the sample as a whole. The total sample size by the number of enterprises was 281560 units, and by the number of employees – 2123678 people.

During the next stage of this study we validated the values of representative samples according to the formula (1) based on the volume of general populations in accordance with the data for 2013. The general population for enterprises located in all federal municipalities of Russia was 2076810 units (with a headcount of up to 250). And the general population for employees working there reached 12406 million. When making calculations, it was assumed that the value of an error margin is 0.005 (0.5%), and the level of confidence is 0.997 (hence, the coefficient $t=3$). The calculation results regarding the minimum values of representative samples are given below:

- for the number of enterprises:

$$n = 1 / \left[\frac{(0,005)^2}{3^2 \times 0,5(1 - 0,5)} + \frac{1}{2076810} \right] = 86207 \quad ; \quad (2)$$

- for the number of employees:

$$n = 1 / \left[\frac{(0,005)^2}{3^2 \times 0,5(1 - 0,5)} + \frac{1}{12406000} \right] = 90909 \quad . \quad (3)$$

Having compared the resulting values with the previously mentioned values of the total number of enterprises and their employees included in the sample for 7 federal municipalities in question (281560 units and 2123678 people, respectively), we may conclude that the initial data is representative.

During the computational experiment, using the data from the summary table we determined how much the enterprises with a particular headcount account for in the total number of enterprises, as well as how much the employees working there account for in the total workforce. Two regression models were then developed for these values. The first model developed by the author describes the correlation of a proportion of small and medium-sized enterprises with a particular headcount in the total number of enterprises. Such model constitutes the following power function:

$$k(x) = \begin{cases} 77,54 \times x^{-1,758}, & \text{если } 1 \leq x \leq 250 \\ 0, & \text{если } x < 1, x > 250 \end{cases} \quad (4)$$



where k – the proportion of enterprises with a particular headcount in the total number of enterprises (%);

x – the headcount of an enterprise (FTEs).

The second model developed by the author describes how much the employees working in small and medium-sized enterprises with a certain headcount account for in the total workforce. Such model constitutes the following exponential function:

$$r(x) = \begin{cases} 2,66 \times e^{-0,028x} + 0,03, & \text{если } 1 \leq x \leq 250 \\ 0, & \text{если } x < 1, x > 250 \end{cases} \quad (5)$$

where r – the proportion of employees working in enterprises with a particular headcount in the total workforce (%);

x – the headcount of an enterprise (FTEs).

The second regression model describes how employees of enterprises are distributed among enterprises with different headcount (i.e. what percentage of employees work in enterprises with this or that headcount).

The quality of resulting regression models was checked according to the generally accepted criteria. Table 2 presents values of the calculated statistics on the quality criteria for both functions developed.

Table 2

Values of the calculated statistics on regression functions

Statistics	Value for	
	function 1	function 2
Determination coefficient	0,991	0,878
Correlation coefficient	0,995	0,772
Calculated value of Fisher-Snedecor test	753,17	27,06
Calculated value of Student's t-test: for function coefficient for factor	19,10	3,71
	27,44	5,20

Source: developed by the authors.

Having compared the calculated values given in table 2 with the value of the criteria presented in sources [1, 2], we can see that the developed models are of high quality. For instance, the determination and correlation coefficients for functions (4) and (5) are close to 1. The calculated values of the statistics exceed the table values which are equal according to Fisher-Snedecor test – 12.25 (at a significance level of 0.01) and, according to Student's t-test, 3.36 (at a significance level of 0.01). The results of a check conducted using significance level values for both criteria suggested that they were all under 0.01, i.e. the results are highly significant and the degree of reliability of the developed functions (4) and (5) is more than 99 %.

The determination coefficient characterizes the level of adequacy and, accordingly, the quality of the regression equation [3]. The closer the determination coefficient is to 1, the closer the developed dependence is to the functional one. According



to N. Draper and G. Smith [16], regression models are successful when the determination coefficients exceed 0.8.

The difference between 1 and determination coefficient describes the proportion of variance, which is due to the effect from other factors not included in the regression function. Analysis of the data in Table 2 suggests that regression models explain 99% of the variation of a dependent variable for the first function and 87% for the second function. Other factors (not considered by us) account for maximum 1% of the first function (4) and 13% of the second function (5), respectively.

The results of a logical analysis conducted with regard to the developed models suggest that they adequately describe the patterns of how both enterprises with different headcount and the values of their workers are distributed throughout the changing of factor X values. It should be noted that the hypothesis put forward in the course of the study was confirmed.

With the samples used in the study being confirmed by the analysis as representative, we can transfer the results to a general population, i.e. to all enterprises of the country (with a headcount of up to 250) and the number of their employees.

The power values in both functions (4) and (5) are negative (-1,758 and -0,028), hence, as the factor value increases, the values of variables decrease monotonically.

The functions (4) and (5) developed by the author as a result of the study allow us to estimate how much the enterprises and employees account for in the total number of enterprises and the total workforce, respectively. To do this, it is necessary to calculate the values of certain integrals from these functions for the corresponding intervals in the change of an argument (the headcount of an enterprise) of these functions. The results of these calculations are presented below.

The analysis of function (4) describing the breakdown of enterprises with different headcount allows us to draw the following conclusions:

- more than a half of the existing enterprises have a staff of under 3 employees;
- 76% of the enterprises have a staff of up to 5 people;
- 84% of enterprises have less than 11 employees;
- almost 90% of all enterprises in the country employ no more than 15 people;
- the enterprises with 100 to 250 employees account for less than 1%;
- about 10% of the total number of enterprises have a headcount ranging from 6 to 11 people;
- about 1% of the total number of enterprises have a staff in the range from 51 to 70 people and from 71 to 100 people.

The analysis of function (5) describing the breakdown of the number of workers employed in enterprises allows us to draw the following conclusions:

- about a half of all employees are employed in enterprises that have a staff of up to 27 people;
- enterprises with a headcount of up to 5 people employ 12% of total workforce;
- almost a third of all employees are employed in enterprises with a headcount of up to 15 people;
- almost 90% of employees work in enterprises with up to 100 people;



- 75% of employees are employed in enterprises with up to 56 people;
- about 5% of the total workforce are employed in enterprises with a staff ranging from 101 to 140 people and from 140 to 250 people. Some problems related to increasing the efficiency of such enterprises are presented in [20, 21].

Of a certain interest is the comparative analysis of the results of this study with the results of modeling the distributions of the number of enterprises and the number of employees according to the data for 2010 [7]. This analysis led to the following conclusions:

- during the period under review, the proportion of enterprises belonging to the group with less than 5 employees increased from 56% to 72%;
- in the group of enterprises with a headcount from 1 to 30 people there was an increase in their proportion from 81% (in 2010) to 94% (in 2013);
- there was a significant reduction (from 5% to 1%) in the proportion of enterprises with a staff in the range of 101 to 250 people.

A similar comparative analysis of the distribution of the number of workers employed in enterprises with different headcount showed the following results:

- during the period under review, the proportion of employees working in enterprises with a headcount of up to 5 people increased from 11% to 12% ;
- in the group of enterprises with a staff from 5 to 15 people, there was a slight decrease in the proportion of employees (from 22% in 2010 to 20% in 2013).

Overall, it should be noted that there is a significant predominance of enterprises with a small headcount, and during the period under review there was an upward trend in the proportion of such enterprises in the national economy. The main reasons for this, in our opinion, are: the improvement of technological processes, including management processes, as well as the performance by employees of different functions in combination. The latter ensures a reduction in the number of employees in an enterprise. However, this leads to the fact that some necessary functions are not performed efficiently, or not performed at all, which may result in higher business risks.

CONCLUSION

Overall, the conducted studies have a certain degree of originality and novelty. The authors describe new knowledge about the current differentiation in Russian regions in terms of the number of enterprises and the number of their employees based on the size of such enterprises. The existence of regression dependences between the studied indicators has been proven. The estimated regression dependences are power and exponential functions that have a high approximation quality.

The results of this study, which contain scientific novelty, include the following:

- the possibility of an analysis of the current distribution of a specific weight of the number of enterprises and the number of their employees using regression models has been confirmed, model specifications have been presented;
- it has been proven that the high quality of initial data approximation is ensured by monotonically decreasing function – for describing the distribution of a specific weight of enterprises with different headcount, and by exponential monotonically decreasing function – for describing the headcount breakdown in these enterprises;



Differentiation of small and medium enterprises based on headcount

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- it has been discovered that large enterprises with more than 251 employees on average account for at most 1% of the total number of enterprises in seven federal municipalities (the Republic of Tatarstan, Perm region, Astrakhan region, Belgorod region, Vologda region, Novosibirsk region, Sverdlovsk region);

- it has been shown that the enterprises with a headcount of up to 250 people are predominated by those where there are maximum 5 people. Those with more than 100 employees account for 1%;

- it has been demonstrated that a half of all employees work in enterprises with a headcount of up to 27 people, and 90% of the total workforce are employed in enterprises with a staff of up to 100 people;

- it has been found that during the period from 2010 to 2013 the proportion of enterprises with less than 5 employees increased from 56% to 72%.

The obtained results are of some theoretical significance, in particular, when studying enterprises with different headcount, improving a legal and regulatory framework for the operations performed by enterprises, creating measures aimed at enhancing the operational efficiency of business entities at all levels of government (federal, regional, municipal). The developed formulas can be used to justify the needs for investments and labor resources, to prepare plans and strategies for the further development of small and medium businesses in all regions of the country and individual municipalities in particular. The proposed methodological approach and tools for assessing the differentiation of enterprises and their headcount can be used when researching entrepreneurship issues, as well as when justifying development programs for this sector of the economy at the federal level. 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 practical significance of the study results also consists in the fact that they may be used by the departments of state and municipal administration responsible for dealing with the issues related to the regulation and support of small and medium businesses, as well as by credit, leasing, transport [14] and other organizations. For instance, the existing structure of workforce should be taken into account when justifying the volumes of lending to small and medium enterprises, the volumes of grants to them, the volumes of investments, as well as for dealing with other tasks related to the support of business entities. Given that enterprises with a small headcount are more prevalent, therefore when making procurements for the needs of regional and municipal authorities it is necessary to reduce in every possible way the size of the lots offered for auction under contracts intended for small enterprises. A half of all enterprises have fewer than 3 people, so the owners (managers) of such enterprises in the course of their activities have to combine many functions and, hence, require knowledge in areas such as management, marketing, taxation, law, accounting and reporting. Taking this into account, one should pay more attention to such tasks of federal and municipal authorities as training of entrepreneurs through workshops, seminars, short-and medium-term courses, development of a network of consulting points and business incubators, as well as the creation of “single window services” for entrepreneurs (i.e. “one-stop-shop” principle).



Urgent problems should be covered on specialized websites of the authorities. When addressing institutional support issues, the existing headcount differentiation in enterprises should be taken into account. Especially in terms of requirements for accounting, bookkeeping and preparing financial statements in small enterprises, which are an absolute majority. It should be ensured that enterprises receive methodological, technological and organizational assistance from banks, tax authorities and service organizations.

Start-up entrepreneurs are interested in information about the current size structure and the average headcount per enterprise. Whereas, experienced entrepreneurs may use the information provided herein for planning further development of their enterprises, including by increasing the number of employees.

The new knowledge obtained herein can be used in higher and secondary educational institutions, as well as for business trainings in our country. In our opinion, the relevant information is of some interest not only for students, but also for entrepreneurs and authorities responsible for the regulation of entrepreneurship in the Russian Federation.

Further studies in this area involve the expansion of studied objects and the inclusion of all regions of Russia. In addition, the analysis of differentiation of enterprises based on the specifics of individual municipalities is of some interest.

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