Identifying economic activities in the Altai region with self-development potential

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Abstract. Based on exponential trends in the number of employees of organizations in the municipalities of Altai region, a method is proposed for identifying types of economic activity, for which the positive and negative feedback operates.

Keywords: economic activity, self-development, potential for self-development, employee, employees of organizations

1. Introduction

Effective management of the development of the economy of a region of the Russian Federation involves identification of trends in the occurring changes, followed by an assessment of favorableness of the latter. In particular, the compliance of the identified changes with the Strategy for the Spatial Development of the Russian Federation for the period up to 2025 [1] and with the Strategy for the Socio-Economic Development of the Region can be assessed.

Due to diversity of natural and climatic conditions, its borderline position, and particularities of historical development, the economy of Altai region has a complex internal structure, with high output of agricultural, industrial, and biotechnological products coupled with advanced research facilities and education, being unevenly distributed over its territory. In this respect, a statistical analysis of the dynamics of the outcome indicators for the region should be complemented by an analysis of changes occurring at the level of municipalities.

Among the most important indicators characterizing the scale of economic activity is the number of people employed in the economy. This indicator is very sensitive to both internal and external factors that determine the development of the region [2]. Its essence can be revealed, for example, in terms of the relationship between the volume of output and labor productivity: an increase (decrease) in the number of employed means that the growth in output overtakes (lags behind) the growth of labor productivity. In the case when the analysis extends over only a small period of time, we can assume that the index of the number of employees acts like a substitute for the index of the output. At the level of municipalities of the region, the number of employees is not published but can be approximated by the average number of employees of organizations.

The objective of our study is to identify, via studying the dynamics of the number of employees of organizations across municipalities and economic activities, which types of economic activity in the Altai region possess potential for self-development (to be defined later), and which do not.

2. Materials and Methods

The Altai region comprises 72 municipalities, three of which were excluded from the study due to absence of recent data: Slavgorodsky municipal district (MD), towns Zmeinogorsk and Kamen'-na-Obi. The economy of Altai region encompasses 18 main types (sections) of economic activities (MTEA) according to *okved2* (see Table 1).

Quarterly averages M_t of the number of employees of organizations for the period from Q1 2017 to Q4 2018, cumulated from the beginning of each year, were used as our research data [3]. These were extracted from so-called passports of municipalities found in the corresponding database and comprised M_t for each available combination of municipality and MTEA.

First of all the data was transformed according to the formula

$$L_t = tM_t - (t-1)M_{t-1} \quad (1)$$

in order to find the average numbers of employees L_t for each quarter t.Consequently, the estimates obtained contain a noticeable proportion of zeros and absent values, as well as outliers with respect to an exponential trend (see later). In order to robustify the results, non-positive values were replaced with onesm and the absent values were replaced with the median of the available observations. Then the exponential trend was fitted to each sequence (combination of MTEA by municipality) of eight L_t values and studentized deleted residuals were found. The values of L_t such that corresponding (negative) residual is less than 0.5% quantile of the t-distribution with 8 – 3 = 5 degrees of freedom were replaced by the medians of the other values.

The following exponential trend model

$$400\log(L_t)=\alpha+\beta\left(t-\bar{t}\right)+\varepsilon_t, t=1,\dots,8 \quad (2)$$

was fitted to the cleaned data, where $\bar{t}=4.5$ is the average time. This form has two advantages: a factor of 400 in front of the logarithm allows one to interpret $\hat{\beta}$ estimate as an average annual growth rate of the series, expressed as a percentage; the time centering allows one to interpret the trend value $\overline{L_G}=\exp(\hat{\alpha}/400)$ at $t=\bar{t}$ as a typical value of the series (it can be shown that it coincides with the geometric mean of L_t). Subsequently, the values $\overline{L_G}$ and $b\equiv\hat{\beta}$ are used as characteristics of the exponential trend.

For each particular combination of municipality and MTEA using the jackknife method. the standard errors $s.e.\left(\overline{L_G}\right)$ and $s.e.(b)$ were calculated, as well as the corresponding t-values: $t\left(\overline{L_G}\right)=\overline{L_G}/s.e.\left(\overline{L_G}\right)$ and $t(b)$=b$/s.e.(b)$. When both inequalities $\left|t\left(\overline{L_G}\right)\right|\geq 2, |t(b)|\geq 2$ hold, we call the trend reliably determined, or it is called "uncertain." Thus, considering also the sign of b, we can classify all the combinations of municipalities by MTEAs with respect to dynamics of the number of employees of organizations into three groups: *decreasing* (D), *undefined* (U), and *increasing* (I).

For each MTEA we calculate the total of $\overline{L_G}$ for each of the three groups: decreasing $\Sigma_D\overline{L_G}$, undefined $\Sigma_U\overline{L_G}$ and increasing $\Sigma_I\overline{L_G}$, their total $\Sigma_T\overline{L_G}$ and corresponding proportions $P_D\left(\overline{L_G}\right)=\left(\Sigma_D\overline{L_G}\right)/\left(\Sigma_T\overline{L_G}\right)$ and $P_U\left(\overline{L_G}\right), P_I\left(\overline{L_G}\right)$ as well.

For all MTEAs and all municipalities for which the trends are reliably determined, we calculate the Spearman's rank correlation coefficient between $\overline{L_G}$ and b, denoted as $r_{\mathrm{DI}}^{(S)}\left(\overline{L_G},\mathrm{b}\right)$. Significantly positive (negative) values of $r_{\mathrm{DI}}^{(S)}\left(\overline{L_G},\mathrm{b}\right)$ mean that the greater the number of people engaged in MTEA in the municipalities of the region, the faster (slower) it grows, i.e. there is a positive (negative) feedback. We interpret these MTEAs as having/not having the potential for self-development.

All computations and data management tasks were performed via R statistical package [4] and its contributed packages XML [5], dplyr [6], stringr [7], tibble [8], reshape2 [9], MASS [10] (studentized deleted residuals, function studres), resample [11] (function jackknife), and knitr [12] (creation of html table, function kable).

3. Results

The parameters of the reliably determined exponential trends (estimates ± standard errors) for the average quarterly number of employees of organizations (according to okved2) of the municipalities of the Altai region from Q1 2017 to Q4 2018 are represented in [13]. It should be noted that a number of trends with a small average number of employees are kept in this table for completeness.

This table shows that:

1. All reliably determined trends for the total of surveyed economic activities, as well as for "Section P Education" and "Section Q Activities in the field of healthcare and social services," are decreasing;
2. In the "Section A Agriculture…," the four municipal districts (Klyuchevsky, Rebrikhinsky, Zarinsky and Kamensky) reliably increased the number of employees;
3. In the "Section E Water supply…," the municipal districts Rodinsky and Topchikhinsky reliably decreased the number of employees;
4. In the "Section F Construction," the town of Rubtsovsk reliably decreased the number of employees;
5. In the "Section I Activities of hotels and catering," the Kosikhinsky municipal district reliably decreased the number of employees;
6. In the "Section J Information and communications activities," the regional capital Barnaul and the Zmeinogorsky municipal district e reliably decreased the number of employees;
7. In the "Section K Financial and insurance activities," the Topchikhinsky, Kosikhinsky, Altaisky, Krasnoshchekovsky municipal districts reliably increased number of employees;
8. In the "Section M Professional, scientific and technical activities," the Pospelikhinsky municipal district reliably decreased the number of employees;
9. Un the "Section O Public administration and military security; social security," the Kosikhinsky, Pervomaisky, Pavlovsky municipal districts reliably increased the number of employees;
10. With the exception of the Kulundinsky municipal district, other municipalities decreased the number of employees, with reliable trends for the activity "Section S Provision of other services."

The main numerical results of the study are represented in Table 1. In view of the nature of values $\overline{L_G}$ and b, we have opted not to use a strict criterion of significance for the Spearman's correlations between them. We consider significant a value of correlation above 0.1 or below -0.1.

11. According to this rather arbitrary criterion, 6 main types of economic activities do not possess a potential for self-development: "Section E Water supply…", "Section H Transportation and storage", "Section I Activities of hotels and catering", "Section J Information and communications activities", "Section K Financial and insurance activities", "Section N Administrative and related supplementary activities."
12. The proportions of the mean geometric number of employees for these activities show that the "Section E" rests in equilibrium, "Sections H, I, and N" develop, "Section J" declines, "Section K" rests in equilibrium or slowly declines, which is possibly due to the growing labor productivity.
13. The following activities "Section M Professional, scientific and technical activities", "Section O Public administration and military security; social security", "Section P Education", "Section Q Activities in the field of healthcare and social services", "Section R Activities in the field of culture, sports, leisure and entertainment", "Section S Provision of other services", "Total for the surveyed economic activities" possess a potential for self-development.
14. The proportions of the mean number of employees show that from these activities only the potential for self-development of "Sections M and R" is used.

15. The potential for self-development of activities of the "Sections O, Q" and a total for the surveyed economic activities is blocked; the potential for self-development of the "Sections P and S" is substantially blocked.
16. Other (not mentioned) economic activities do not possess a pronounced positive or negative feedback for their development.

Table 1. Generalized characteristics of the dynamics of the average number of employees in organizations of the Altai region from Q1 2017 to Q4 2018. Economic activities with a self-development potential are in bold.

No	Main type of economic activity	Proportion of mean geometric number of employees, %			Spearman correlation
		Decrease	Stability	Growth	
1	Section A Agriculture, forestry, hunting, fishin,g and fish farming	65.6	29.5	4.9	0.07
2	Section C Manufacturing	13.5	35.5	51.0	0.04
3	Section D Electricity, gas, and steam supply; air conditioning	16.5	43.6	39.9	0.08
4	Section E Water supply; water disposal, organization of collection and disposal of waste, pollution control activities	3.3	86.4	10.3	-0.67
5	Section F Construction	0.5	99.1	0.4	0.03
6	Section G Wholesale and retail trade; repair of motor vehicles and motorcycles	66.4	31.0	2.6	-0.01
7	Section H Transportation and storage	29.1	20.8	50.1	-0.10
8	Section I Activities of hotels and catering	2.8	30.5	66.7	-0.48
9	Section J Information and communications activities	91.7	1.7	6.7	-0.45
10	Section K Financial and insurance activities	13.8	85.4	0.9	-0.40
11	Section L Real estate operations	90.3	2.8	6.9	0.08
12	Section M Professional, scientific, and technical activities	**1.8**	**6.5**	**91.7**	**0.12**
13	Section N Administrative and related supplementary activities	13.1	11.2	75.7	-0.32
14	Section O Public administration and military security; social security	**37.7**	**58.7**	**3.5**	**0.38**
15	Section P Education	**86.8**	**13.2**	**0.0**	**0.34**
16	Section Q Activities in the field of healthcare and social services	**51.1**	**48.9**	**0.0**	**0.30**
17	Section R Activities in the field of culture, sports, leisure, and entertainment	**7.1**	**27.8**	**65.1**	**0.16**
18	Section S Provision of other services	**88.5**	**11.2**	**0.2**	**0.59**
	Total	**70.7**	**29.3**	**0.0**	**0.38**

4. Discussion

The proposed analysis constitutes the second try to classify the economic activities of the economy of a region of Russian Federation from the viewpoint of presence/absence of potential for self-development. The first one pertaining to the Saratov region is due to V. L. Somov (in press).

Despite the relative simplicity of the approachm we believe its results do reflect our qualitative understanding of the regional economic system. The main difficulty of the proposed method consists in overcoming the impact of noise, which is inherent in observations on the lowest level of aggregation.

The proposed approach can possibly be elaborated by replacing a correlation analysis with a statistical model describing the relationships between some characteristics of the level of economic

activity in a municipality with its growth rate. In any case, the nature of the data obliges to develop econometric models based on thick-tailed distributions or to use robust methods of estimation.

5. Conclusion

From our point of view, the proposed analysis method based on studying the data on the number of employees in organizations gives a pertinent insight in the difficult question of guiding the process of development of the economy of Altai region. Our study shows that the economy of Altai region (reflected in the total number of employees of organizations) has a potential for self-development, but now it is blocked by some factors. We do not claim that the development of an economic activity is impossible without the potential of self-development, but it is rather clear that it is much easier to contribute to development of an activity with such a potential in the terms of relationship between the efforts expended and results obtained. In our opinion, the best performance can be achieved by unblocking the potential for self-development, compared to spending resources to force the development of activities not possessing such a potential.

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