

Multidimensional modeling of regions by employment and socio-economic development

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Abstract. Employment is essential for development. Employment can increase income of people and household, reduce inequality. Employment promote economic growth and promote stability of country. We carried out a comprehensive analysis, which reflected the situation and the connection with the market of labour force (particularly population employment), the population's standard of living (particularly its income). Scientists today make efforts to study the lasting aspects, facts of employment and the state of the labour in general. An empirical distribution of the studied regions into 3 clusters was made. It is possible to obtain sufficiently high production results and, consequently, increase the population's standard of living. Cluster 1 regions are encouraged to more actively introduce new technologies and scientific developments into the production process. The regions of cluster 3 are recommended to adopt the experience of organizing the management of production processes, technological changes. How the population will live today depends on production and management, including the labour market. The research defines the directions for future research.

1 Introduction

The labour market is the most crucial resource in the business environment. Today, the situation in the labour market is ambiguous (Joma & Zvirgzdina, 2019). Improving the employment situation is a challenge for every country. Employment is essential for development. Employment can increase income of people and household, reduce inequality (Behar & Mok, 2019). Today, the most important indicator of the living standard of population is the monetary income of the population. Our idea was to make a comprehensive complex analysis that, in aggregate, will reflect the situation and the connection with the market of labour force and income of the population. Usually, employment is surveyed in the short term; observations are carried out monthly to consider different types of employment. However, today scientists make efforts to study the lasting aspects, facts of employment, the state of the labour in general, conducting dynamic research. Thus, Nadoveza Jelic et al. (2020) investigated spending on active and passive labour market policies on labour market outcomes for 15 countries in 1990-2017. The effects depend on the country and the type of policy (Nadoveza Jelic et al., 2020). Gajdos et al. (2020) examined the movements in the structure of the employment indicator and the available qualifications. We examined the

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driving forces of these changes – from technical changes and modernization of education to institutional reforms – paying great attention to the hypothesis of the polarization of the labour market. Lysenko (2019) noted that short-term studies predominate. These studies show that the responses of firms or industries to sharp changes in the real exchange rate are not uniform.

In long-term research, scientists inevitably touch upon legal aspects. Ferreiro (2020) analyzed how legislation related to the protection of employment and the employed population affects, changes in the economic situation and activity affect on the dynamics. O'Mahony et al. (2019) explored the possible causes that influenced the decline in the level of the labor force in the structure of the population, studying how the applied technologies affect the rules of the market. Herzberg-Druker and Stier (2019) highlighted the importance of changes in both education and participation in production as an important scheme for increasing income inequality. Employment studies and their impact on income levels, social aspects of state activities, and cultural traditions are necessary. Asquith et al. (2021) measured the strength of networks in the labour market. Moriconi and Peri (2019) noted that European countries show significant differences in adult male employment rates. Differences in average preferences for work and leisure, determined by cultural values that differ from country to country, maybe part of these differences. However, differences in labour market institutions, productivity and labour force skills are also decisive factors and likely correlate with preferences. Country-specific work and leisure preferences explain about 24% of the difference between upper and lower employment levels in European countries (Moriconi & Peri, 2019). Berloff et al. (2019), Popkova E.G. (2022) and scientists (2022) presented a new approach to assessing how development of the conditions of employment of individuals over some time affects the quality of employment of individuals, rather than the quality of work performed in a specific given period. On the same issue, Trlifajova and Hurre (2019) noted that the central dilemma of current security policy is how to ensure the necessary social protection of the population and how to come up with incentives for job search. Ilkcaracan et al. (2021) used applied modelling and simulation of macro and micropolicy to study the impact of the gender aspect in increasing the state budget and state expenditures on the education of preschool children, education at preschool age on the employment rate of the population and the amount of income received. Wang et al. (2020) studied the technology influence on the distribution of employment and the employment status in the distribution of income in China. O'Mahony et al. (2019) studied how labour productivity and capital productivity affect the conjuncture of market of labour force.

This study aims to group the regions by the cluster analysis on a set of indicators characterizing both the market of labour force and socio-economic development; to draw well-grounded conclusions and outline the prospects for further research in this area. In this study, we use aggregated data, statistical data, macroeconomic indicators in the regional context. On the whole, as the review of world studies shows, we went in the right direction.

2 Methods and materials

The methodology of the presented study is multivariate statistical grouping. The overall level of employment in the context of investment and scientific activity, a multiple grouping of Russian regions was made using a multidimensional division of the population into clusters. This analysis made it possible to study the current spatial distribution of regions according to selected indicators of economic development. In this case, the classification is carried out simultaneously for the entire complex of features. Analysis was made with the STATISTICA program. When classifying regions, we used indicators measured in disparate units. Therefore, standardized coefficients of the initial values of the variables were used. The information array was analyzed for 2021. The indicators for calculating the multivariate

average were average monetary income, USD per capita of the population; investments in fixed assets, thousand USD per capita; share of the population in age of working in the total population,%; regional product (thousand USD per capita); total fertility rate (number of children per woman); morbidity per 1000 population (registered diseases in patients diagnosed for the first time in life); employment rate (according to sample labour force surveys),%); average monthly salary, USD; urban population such a share in the total population,%.

3 Research results

Models of multiple correlation-regression analysis were built, allowing to measure the degree of strength of the connection between the result and the factors selected in the process of meaningful theoretical analysis. The analyzed aggregate did not include Sevastopol, Moscow, St. Petersburg. Some regions were not included due to the data lack on some of their indicators. In the presented analysis, all signs are expressed quantitatively. Therefore, the strength of the relationship between the indicators was assessed by calculating the paired correlation coefficients and the linear multiple correlation coefficient. Also, for more informative analytics, partial regression coefficients for each factor, elasticity coefficients and beta coefficients were calculated.

We will conduct cluster analysis, a grouping of regions. Clustering showed the picture of the unification of clusters (Fig. 1).

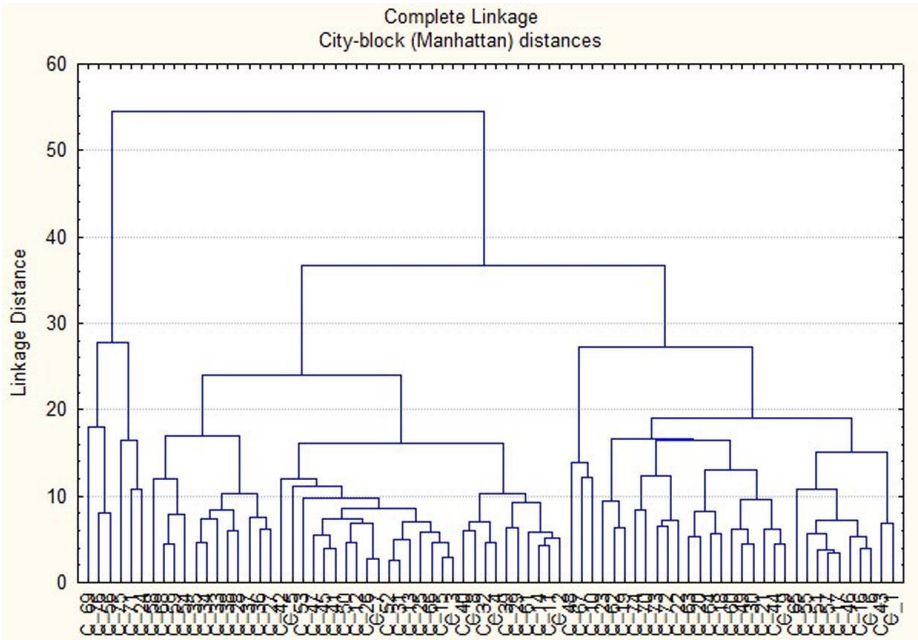


Fig. 1. Clusters of the territories of Russia.

The division of the territories of the Russia into clusters was made. The selected groups of regions are presented in Table 1.

Table 1. Characteristics of clusters of regions of the Russia.

Cluster	Cluster composition
I	The Republic of Sakha (Yakutia) Regions: Sakhalin, Tyumen, Magadan, Murmansk Kamchatka Territory
II	Regions: Tula, Belgorod, Yaroslavl, Kaluga, Lipetsk, Moscow, Arkhangelsk, Kaliningrad, Astrakhan, Perm, Nizhny Novgorod, Orenburg, Samara, Chelyabinsk, Sverdlovsk, Krasnoyarsk, Irkutsk, Novosibirsk, Kemerovo, Tomsk, Vologda, Leningrad, Amur Republics: of Karelia, Komi, of Tatarstan, Udmurt, of Khakassia Territories: Trans-Baikal, Primorsky, Khabarovsk
III	Regions: Kurgan, Ivanovo, Ulyanovsk, Kirov, Penza, Ryazan, Pskov, Kostroma, Saratov, Volgograd, Smolensk, Novgorod, Omsk, Tver, Vladimir, Kursk, Rostov, Voronezh, Stavropol, Krasnodar, Altai, Tambov, Oryol, Bryansk Republics: of Altai, of Buryatia, of Tyva, Kabardino-Balkar, of Ingushetia, of Dagestan, Chechen, of Kalmykia, of North Ossetia – Alania, Karachay-Cherkess, of Adygea, of Mordovia, Chuvash, of Mari El, of Bashkortostan

The first cluster include six regions, or 7.9% of the studied population, the other cluster include 31 regions, which is 40.8% of the population, the third cluster contains 39 regions (51.3%).

According to the requirements of statistical science, one group should not contain half or more of the population units. But we made 3 clusters. In contrast to a simple grouping, which allows you to exclude a group technically, this is a multidimensional grouping based on more complex calculations based on many indicators. It was also possible to divide the population into 5-6 clusters (judging by the graph); however, we chose to divide into 3 clusters - the best, average, worst in terms of indicators.

Assessment of indicators is shown in Table 2.

Table 2. Results of a multiple grouping of regions of the Russia.

Indicators	Cluster 1	Cluster 2	Cluster 3	Russian average
Number of regions	6	31	39	76
Regional product, thousand US dollars per capita	21.93	7.92	4.32	8.89
Employment rate, %	65.8	58.9	55.3	68.4
The urban population in the total population, %	82.7	75.3	63.3	74.7
The rural population in the total population, %	17.3	24.7	36.7	25.3
The population of working age in the total population, %	59.4	56.2	55.5	68.3
Share of industrial production in GVA, %	50.3	42.3	25.4	38.6
Small business turnover per capita, USD	4623.5	4462.9	2891.9	6680.8
Fixed capital investment, USD per capita	5342.7	1928.7	1052.3	2039.2
Investment in fixed assets, USD per capita (average in the previous five years)	5636.5	1792.9	1049.9	1887.9
The level of innovative activity of organizations, %	8.6	8.8	8.3	8.1
Internal expenditures on research and development per employee, USD	111.0	162.0	60.3	247.4
Internal expenditures on research and development per employee on average in the previous five years, USD	116.8	152.4	61.2	238.3

GRP per employee, thousand USD (labour productivity)	38.65	16.75	10.04	18.39
Average monthly wages of employees of organizations, USD	1220.2	645.3	484.7	741.6
Average monthly wages of employees of organizations on average in the previous five years, USD	1096.9	590.0	445.6	664.3
Wages in income of the population, %	71.9	59.7	48.6	57.7

Cluster 1 is characterized by the highest level of gross regional product, the highest level of employment, the share of the urban population, the level of industrial production in gross value-added, and labour productivity. These regions have the highest level of investment, both according to annual data and data for the previous five years. This cluster includes the northern regions that traditionally show the highest earnings. However, the level of innovation activity in these regions is hardly the highest, indicating a particular technology tradition and immutability.

Cluster 2 is characterized by almost average indicators. These are the regions that achieve good indicators for their territorial location. In the regions of this cluster, there is a rational use of resources, rational production conditions, highest level of innovative activity of organizations and the cost of research and development. As a result, under relatively average conditions, good results of production, good results of living standards are obtained, indicating the effectiveness of scientific developments, their use in production, and the population's life. In cluster 2 regions, the practical work of the management staff of enterprises and regional management bodies has also been formed.

Cluster 3 is characterized by the lowest values of almost all indicators used to divide regions into clusters and analyse them. The highest level was observed in the share of the rural population, the part of industrial production in gross value added. Consequently, the regions in cluster 3 are predominantly represented by rural regions, with a predominance in agriculture production, the high level of development and results of agro-industrial complex. There is an level of innovative activity of organizations. It indicates a relatively high use of modern digital technologies, innovative agricultural production systems. Further, it is necessary to control the results of technologies to improve the population's living standards, increase incomes, and increase labour productivity.

3 Discussion of the results

We analyzed the results obtained in our study and the results of studies by other scientists. Our results are the same with other research in this area. Lysenko's study showed that the real actual strengthening of the exchange rate in the long run causes a significant reduction of employment in the economy in the industry. Both employment and real wages are rapidly reaching long-term equilibrium (Lysenko, 2019). We also cover a relatively long period in our study. In retrospect, you can find the causes of events, moments of change. The results of Ferreiro and Gomez (2020) showed that a large effect of employment protection depends on the choice of analysed years and countries (Ferreiro & Gomez, 2020). Mattijssen and Pavlopoulos (2019) applied multichannel sequential analysis of positions and incomes in the labour market to develop types of careers, including various types of employment, permanent and temporary. The analysis of the identified types showed that 29.6% of those analyzed have a career type with a high level of employment and a high level of income. 39.7% are in the low-employment, low-income career type (Mattijssen & Pavlopoulos, 2019).

Asquith et al. (2021) say that establishments in several non-profit industries are considered a predictor of strong networks in the labour market (Asquith et al., 2021). Aldan argues that employment rates in the public sector have a positive influence on employment

rates in private business. However, the result obtained is in conflict with earlier findings that employment in the public service is crowding out employment in private business in developed countries (Aldan, 2021). Research results show that a high level of employment in the civil service neutralizes a large negative impact on employment in the private business, without assessing the level of assessment in the survey. Instead of creating jobs in the public service, financial resources would be better used to pool development efforts (Behar & Mok, 2019). Schneck (2020) confirmed that self-employment is the reason why incomes differ in the labour market. Ravallion (2019) has critically examined the arguments for and against job security and income security, seen as rights-based policy instruments for poverty reduction in developing economies. Research results of Berloff et al. (2019) showed that there is a rather urgent problem of increasing the opportunity for women to get a permanent job and increase the distribution of labour income. Trlifajova and Hurrell (2019) argue that it is wrong to ask that the work itself should be paid. Monetary motivation should be that whoever works - receives income. The reasons why the household is poor must be found (Trlifajova & Hurrell, 2019) consistently. Therefore, it is essential to study the relationship of indicators and the reasons for the changes.

Ilkcaracan, Kim, Zacharias found that an increase in spending on expanding preschool education services at the level of 1.8 % of Product provides employment for more than a million workers and creates new jobs for the unemployed population. The results showed that job creation through increased spending on social assistance could create significant numbers of gender-balanced jobs (Ilkcaracan et al., 2021). Where there is a woman, there is more often culture and traditions. Scientists pay great attention to this. In our article, we included total fertility rate as a factor affecting per capita income. This indicator is aggregated and directly or indirectly takes political, cultural, religious, gender, and economic aspects into account.

Dang and Nguyen (2021) noted that COVID-19 caused unprecedented turmoil in the world economy. Women's fear is that their wage cuts will be twice as much as men's. Factors such as different levels of participation of men and women in work can play an essential role in these differences. Studies point to gender differences across countries. This was influenced by different levels of morbidity and differences in the participation of women in the labour market (Dang & Nguyen, 2021). O'Mahony et al. (2019) have shown that productivity gains, the diffusion of capital in information and communications technology are the primary sources of declining labour force shares. The protection of intellectual rights is the aspect of the environment that influences the share of industry incomes attributable to labour (O'Mahony et al., 2019). Institutional and technological differences are not the primary source of fluctuations in the movement of the share of the labour force (Aldan, 2021). Regression results in studies Wang et al. showed that capital-oriented technology degrades the status of labour income and tends to alter the distribution of employment and labour income between industries (2020). Gajdos (2020) predicted changes of structure in the labour market and tested whether they are consistent with the technological change hypothesis focused on routinization. Presented future changes in labour demand based on the forecast of employment by occupational groups and skills until 2025 (Gajdos et al., 2020). We consider various aspects of the technical equipment, application of innovative and digital technologies, the implementation of investments in the regions of the Russia using cluster analysis.

4 Conclusions

The distribution of Russian regions into 3 clusters was obtained. The analysis showed that it is possible to obtain sufficiently high production results and, consequently, increase the population's standard of living. Cluster 1 regions are encouraged to more actively introduce new technologies and scientific developments into the production process. The regions of

cluster 3 are recommended to adopt the experience of organizing the management of production processes, technological changes. Improving the standard of living today depends on production and management.

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