

Clustering Russian regions as a method of predictive analytics for effective regulation of informal employment

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Abstract. Informal employment covers significant segments of the Russian population. This prevents the increase of poverty, inequality and the growth of well-being, creating «traps» of sustainable development. The article is devoted to the study of the main causes of the spread of informal employment in the labor market of Russian regions using expert analytical methods, analysis of statistical data series and clustering. Classification of regions was built on the basis of the k-means algorithm, which made it possible to minimize variance within regional groups and build clusters based on weighted standardized data. In each cluster, regions have similar characteristics in terms of criteria for the ratio of shadow employment and income. This study is one of the first attempts to cluster regions using Ward's hierarchical method according to the criteria «income of the population - informal employment». Clusters of Russian regions constructed and visualized using the RStudio programming language showed that informal employment strongly correlates with the «low welfare» zone: the lower incomes of the population, the greater part of it works informally. The scientific novelty of the study is to identify the main factor of high informal employment in Russian regions - relative and absolute poverty of the population. The practical significance of reducing shadow employment lies not only in improving the efficiency of regulation of regional labor markets, increasing the revenues of the budget system and the standard of living of the population, but also in modernizing approaches to ensuring the demographic security of the regions of Russia.

1 Introduction

The world economy is developing in a state of high volatility, the causes of which lie in socio-demographic, environmental-epidemiological, military-political and international instability. The current phase of volatility came in 2020-2021, when, as a result of the pandemic coronavirus infection that swept almost the entire population of the Earth, the economies of even the most developed countries experienced the deepest recession in recent decades. Thus,

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in 2020, the world GDP shrank by 4.3% and the GDP of G20 countries shrank by 3.3% [29]. The International Labor Organization (ILO) estimates that in 2020 there was a temporary closure of almost 500 million full-time jobs [27], resulting in 110 to 150 million people of the planet in poverty at the beginning of 2021 [21].

ILO experts believe that employment recovery has not occurred even in 2022, when the global underutilization of working hours was equal to the loss of 52 million jobs [22], and this was despite the GDP growth of most of the countries affected by the pandemic. Against the backdrop of total job closures and plummeting incomes due to the pandemic, the world's shadow economy, which is closely linked to informal employment, estimated by the ILO at more than 2 billion people, or 62% of the world's working population, has grown markedly [21]. However, even before the pandemic, more than 2 billion people were employed in the informal economy. According to the ILO report «Women and men in the informal economy - A statistical picture» (2018), 93 per cent of global informal employment was in developing countries, and only 7 per cent of informal employment is found in high-income countries [28].

In a number of studies, for example, Chen M., Carré F. [13], Radchenko N. [16], Williams C.C., Horodnic A.V. [4] show that a greater number of informally employed is observed in regions and territories with a high level of corruption in the public sector and a low level of economic development. In their work Yeung W.-J.J., Yang Y. [25] note that the most vulnerable in the labor market today are young people without education and relevant professional skills, women and migrants. Moreover, unemployment among young people is growing at a higher rate than among the adult population, belonging to the main category of able-bodied citizens, in this regard there is a high risk of formation of the «generation of exclusion» [25, p.9]. [25, p.9]. On the other hand, in the work of Dzhiyoev A.V. [2] shows that the informal sector provides people deprived of formal employment often casual income, it allows young people to accumulate experience in professional activities, and aspiring entrepreneurs - to save on taxes, providing the prerequisites for the incubation of new businesses. Nevertheless, in a wide range of studies Kanninen V., Pääkkönen J., Schneider F. [23], Sim W.J., Huam H.T., Rasli A., Lee T.C. [24], Luttmer E., Singhal M. [7], Neck R., Wächter J.U., Schneider F. [19] identified the negative effects of informal employment and proved that unemployment along with tax burden, social security and tax morale has a significant impact on the size of informal employment. In turn, informal employment has a negative impact on subjective perceptions (feelings) about their own well-being even if the income is comparable to the income of the officially employed, Karabchuk, T., Soboleva, N. [20].

On the basis of data analysis of international empirical studies in the works of Flores, A., Argáez, J. [1], Adair P. [17], Chen Y., Xu Z. [30], Gomez-Torres M. J, Santero J. R., Flores J. G. [15] showed a significant relationship between the poverty rate and the degree of participation of women and men in the informal sector. Larsen, C., Rand, S., Schmid, A., Bobkov, V., and Lokosov, V. [3] point out that people with a high risk of poverty are more likely to take informal jobs where the types of employment require a low level of skills and competencies.

Informal employment, functioning in parallel with formal employment, significantly deforms the labor market, leads to the degradation of social and moral and ethical values of the population, noted in the work of Sim W.J., Huam H.T., Rasli A., Lee T.C. [26]. The latter, in turn, «inevitably entails the growth of organized crime and corruption, as the expansion of informal employment, in fact, accelerates the social stratification of society, leads to asymmetry of information in the labor market, distorts the established ideas about successful life strategies and, ultimately, to the social transformation of the whole society and the growth of inequality», - noted in the World Bank international study of shadow employment [12].

Since the scale of informal employment varies greatly between countries, as well as between regions of different countries, as it is noted in the works of Medina L., Schneider F. [8] and Enste D. [6], it can be assumed that the informal economy increasingly affects the reproduction, structure, settlement of the population and its demographic behavior.

Thus, the level of informal employment is an important indicator of the well-being not only of the economy, but also of the nation as a whole, and its dynamics quite fully reflects the efficiency of the labor market functioning, the quality of economic regulation and the competitiveness of the state in the world.

The scale of informal employment in Russia has always been significant for three decades: in terms of the size of the shadow economy in 2013, the country ranked fourth in the top 5 largest economies in the world, and in terms of the level of informal employment, it was among the top ten countries in the world. According to the official estimates of Rosstat, in 2013 its level reached about 22 million people [<https://rosstat.gov.ru/folder/11110/document/13265>]. Despite all the mostly declarative measures taken by the Russian government, the scale of informal employment in Russia for the first time decreased during the coronavirus recession of the Russian economy, when, against the backdrop of a sharp increase in unemployment, a decrease in the welfare and quality of life of the population, informal employment during the first wave of coronavirus infection (March - June 2020) unexpectedly decreased by 6.25% (925 thousand people) [2]. Such a noticeable drop in informal employment, in our opinion, is explained by the effectiveness of the comprehensive program of the Russian Government, which was aimed, on the one hand, at social support for citizens registered as unemployed in employment services, on the other hand, at supporting partial and part-time employment of the population as part of the implementation of government measures to support business. During the quarantine period, many workers have completely lost their wages due to the closure or downtime of enterprises. The most vulnerable segment of the labor market was the informal one, which could not qualify for state support. In this regard, it was the incomes of the informally employed that received a more significant blow from the consequences of the pandemic. At the same time, some Russians officially obtained the status of unemployed in the Employment Centers, mostly for the sake of unemployment benefits, while continuing to work in the informal sector. Nevertheless, according to Rosstat, in 2021, informal employment amounted to 14.6 million people (or 20.3% of the total employed population); and in 2022 it decreased to 13.4 million people (or 18.6%). And in the first quarter of 2023, according to Rosstat, 12.7 million people worked in the informal sector of the Russian economy [<https://rosstat.gov.ru/folder/11110/document/13265>]. Thus, over 10 years, informal employment in Russia has decreased by 10 million people. However, due to the spatial heterogeneity of the country's development, the level of informal employment, as well as the unemployment rate, in the most and least developed regions of Russia differs by more than 2 times, which is an important area of research in terms of identifying the drivers of regional employment in the informal sector and developing inclusive measures. its spatial smoothing and reduction.

The aim of the article is to build a classification of regions by the criterion "average per capita income - informal employment" on the basis of cluster analysis, to assess the degree of spatial differentiation of informal employment in Russian regions, to substantiate the hypothesis of direct correlation between low incomes and high informal employment, paying special attention to the North Caucasus Federal District of Russia as the most labor-deprived and least economically developed.

2 Materials and Methods

For the study of informal employment, the paper uses official data from Rosstat. In particular, these are data from the compilations «Regions of Russia. Socio-Economic Indicators» (<https://rosstat.gov.ru/folder/210/document/13204>), data from the compendium «Labor and Employment in Russia» (<https://rosstat.gov.ru/folder/210/document/13210>) and «Results of a sample survey of the labor force» (<https://rosstat.gov.ru/compendium/document/13265>) for 2019-2023.

According to the methodology of Rosstat (2020), informal employment (the criterion for defining informal sector units is the absence of state registration as a legal entity) includes persons employed in at least one of the production units of the informal sector during the survey period, regardless of their employment status and whether this work was their main or additional job. And informal employment includes the employed population aged 15 years and older, at the place of their main job:

- in the sphere of entrepreneurial activity without forming a legal entity;
- employed by individuals, individual entrepreneurs and farms;
- in their own households producing agricultural, forestry, hunting and fishing products for sale or exchange.

In the course of the study we used analytical and expert methods, methods of analysis of statistical data series, clustering and cartography. Analytical grouping of regions was performed on the basis of the k-means procedure, a machine learning algorithm that solves the problem of hierarchical integration clustering. The choice of the k-means algorithm is explained by its simplicity, clear realization and sufficiently high quality of grouping a large number of objects, in our case - 85 Russian regions. K-means is well suited for confirming hypotheses about the number of clusters and can use data from previous computations, or simply from an intuitively chosen number. At the first step, the k-means algorithm assumes the allocation of a given number of clusters, and in the subsequent step contributes to the distribution of regions so that each should belong to exactly one cluster according to the criterion of maximum proximity to the center of this cluster, which is constructed as a result of several consecutive iterations [14]. The calculations of clusters of Russian regions and their mapping were performed using RStudio, a free software development environment for the R programming language [18]. RStudio is widely used for statistical data processing and graphics in socio-economic research.

The algorithm of clustering of Russian regions included the following procedures:

- the choice of such explanatory criterion indicators of informal employment as "level of GRP per capita" and "average per capita income of the population" was justified and on this basis the necessary database was formed;
- k values - the number of clusters into which these data can be divided were determined;
- according to the selected k (centroids) the nearest distances (Euclidean) from the given points to the centroids were calculated,
- at the first stage, seven regional clusters were constructed according to the points that turned out to be closest to these centroids, similar to our previous clustering of Russian regions [9];
- based on the analysis of the objects included in the clusters, new centroids were constructed following the rules of the k-means algorithm: a part of objects moves away from the centroid and starts to enter another cluster;
- as a result of a number of iterations, we identified five clusters of regions with minimal dispersion within their groups.

Thus, a hierarchical clustering of 85 Russian regions by the criterion «level of GRP per capita - level of informal employment» and by the criterion «average per capita income of the population - level of informal employment» was implemented; they were graphically and

cartographically represented in the paper.

3 Results and Discussion

Among the goals of sustainable development - the global agenda for growing prosperity and preserving our planet in the first half of the twenty-first century - are poverty eradication, good health and well-being, education and inequality reduction. These problems are well solved in conditions of decent work and effective employment and, on the contrary, are preserved in conditions of unemployment and shadow employment.

The results of our research on informal employment in Russia allow us to conclude that this phenomenon is associated with a number of reasons, among which are the following: limited number of jobs with decent wages in the formal sector, technologically primitive, socially unattractive and low-paid employment among socially unprotected segments of the population; high inequality in society; the low level of labor incomes of the population, forcing the economically active population to part-time jobs in the lower-paid - according to some estimates, 30% lower - informal sector of the economy; competition in the labor market and others.

The study is devoted to proving the hypothesis that the main reason for the large-scale spread of informal employment, covering more than 13 million employed people with a hidden wage fund at the level of 12-15% of GDP, are low incomes of the population, which led to the preservation of poverty of entire regions of Russia, a drop in people's living standards, lagging human development, growth anxiety and depression of society. Ultimately, inefficient employment, falling real incomes of the population, as well as its weak social security are significant factors in maintaining the 5-year trend of depopulation of the Russian nation (Fig.1).

Table 1 The population of Russia in 2018-2021, million people

Year	Population of Russia	Year	Population of Russia	Year	Population of Russia
2017	146.8	2019	146.8	2021	146.2
2018	146.9	2020	146.7	01-06. 2022	145.2

Source [<https://rosstat.gov.ru/folder/12781>]

In the conditions of continuing socio-economic and military-political instability, there is a high probability of not only maintaining, but also increasing the scale of the shadow sector of the economy and employment in it.

The shadow labor market is formed by stable informal institutions that function in substantial independence from the state, thereby creating a turnover of capital, goods, and labor in parallel with the official economy. This harms not only the state treasury, but also forms the skills and the need for a part of the able-bodied population to provide themselves with income without the help and participation of the state, which contributes to the development of antagonistic relations, which is very dangerous for social stability in the medium term. At the same time, employment in the informal sector in Russia acts as a social stabilizer that amortizes the shortcomings of the economic system, such as: high costs of doing business (high level of tax burden) and constant often unjustified changes in the taxation system; high level of corruption in the state regulatory bodies of the social and labor sphere - in the Ministry of Internal Affairs, other supervising bodies; the population's distrust of the state redistribution of taxes collected in social transfers, high unemployment among young people, especially in basic and secondary vocational education; conservation of the number of jobs in the corporate sector, as well as high opacity of regulation.

Thus, informal employment is a natural adaptation of the labor market to the existing economic conditions, and its reduction lies in the area of overcoming poverty, increasing the effectiveness of state regulation of employment and the development of institutional provision of people's right to decent work. The thesis about the direct correlation between informal employment and regional incomes, expressed by the ratio of median income to the cost of a fixed set of goods and services, is confirmed by comparing its parameters in the most and least prosperous regions of Russia (Table 2).

Table 2. The ratio of the positions of Russian regions in terms of income and employment in the informal sector of the economy, 2022

The region's place in the population income rating	Region	Ratio of median income to the cost of a fixed set of goods and services	Proportion of the population below the poverty line, in % of the total population	Change in the proportion of the population below the poverty line, in 2021-2022, pp	Employment in the informal sector, % of the total employed population
Regions that are leaders in terms of population income are regions with the lowest informal employment					
1	Yamalo-Nenets Autonomous Okrug (YaNAO)	3.24	4.5	-0.1	9.4
2	Nenets Autonomous Okrug (NAO)	2.97	9.0	-0.3	7.3
3	Moscow	2.63	5.0	-0.5	3.4
4	Magadan Region	2.59	7.4	-0.5	19.2
5	Chukotka Autonomous Okrug	2.52	6.7	-0.6	1.5
6	Saint Petersburg	2.31	4.5	-0.5	6.7
7	Sakhalin region	2.28	7.0	-0.4	21.5
8	Khanty-Mansi Autonomous Okrug - Yugra	2.21	7.3	-0.9	7.9
9	Moscow region	2.18	5.5	-0.5	9.0
10	Murmansk region	2.12	8.0	-1.3	6.8
Regions that are leaders in terms of informal employment are regions with the lowest incomes					
85	The Republic of Ingushetia	1.0	30.5	1.2	54.3
50	The Republic of Dagestan	1.50	14.2	-0.5	50.9
70	Kabardino-Balkarian Republic	1.36	16.4	-1.7	47.9
71	Chechen Republic	1.3	19.4	-0.4	45.1
82	Altai Republic	1.05	20.4	-2.0	38.9
83	Karachay-Cherkess Republic	1.04	22.0	-0.1	38.7
67	Republic of North Ossetia-Alania	1.38	13.0	-0.4	36.8
79	Stavropol region	1.23	11.7	-1.3	33.9
25	Republic of Adygea	1.64	11.6	-0.1	31.5
69	The Republic of Buryatia	1.38	19.0	-0.5	30.6

Source [Results of a sample survey of the labor force 2022. <https://rosstat.gov.ru/compendium/document/13265>; Regions of Russia. Socio-Economic Indicators. 2022. (<https://rosstat.gov.ru/folder/210/document/13204>)]

As shown in Table 2, the top 10 regions in the ranking of regions by population income are also the regions with the highest level of median income relative to the cost of a fixed set of goods and services (from 3.24 - 2.97 in the oil-producing YNAO to 2.12 in the Murmansk Oblast); and it is in these leading regions by population income that the lowest level of informal employment is found - less than 10%, with the exception of the Sakhalin and Magadan Oblasts, where 21.5% and 19.2%, respectively, are employed in the informal sector.

The regions in the lower part of Table 1 have relatively low ratios of median incomes to the cost of a fixed set of goods. The Republic of Ingushetia, which closes the ranking in 85th place, has a ratio of 1,0. This means that the average resident of Ingushetia is about three times poorer than a resident of the Yamalo-Nenets Autonomous Okrug. At the same time, Ingushetia ranks first in terms of informal employment - 54.3% of the total employed population work in the informal sector. The list of regions presented in the second part represents the top 10 regions by the level of informal employment, where it is above 30% of the total employed population and ranges from 53.4% in Ingushetia to 30.6% in Buryatia. And as can be seen from Table 1, regions leading in terms of informal employment (Adygea and Dagestan are the exceptions) make up the list of outsiders in the rating by population income: the average value of the indicator «The ratio of median income to the cost of a fixed set of goods and services» here is 1.24. It should be noted that only 15 regions have this indicator that does not exceed 1.3, most of them are part of the North Caucasus Federal District, and these regions have the highest informal employment, which in the period 2020-2022 has slightly increased against the background of the highest level of poverty (Table 3, Fig. 1, Fig. 2).

Table 3 Population with cash incomes below the poverty line (subsistence level) in Russia as a whole and across the Russian Federation in 2020-2022, % of the total population

	2020	2021	2022
Russian Federation (RF)	12.1	11.0	9.8
Central Federal District (CFD)	10.7	10	9.3
North-Western Federal District (NWFD)	12.1	11.5	10.6
Southern federal district (SFD)	14.3	13.7	12.4
North Caucasian Federal District (NCFD)	20	18.6	18.2
<i>The Republic of Dagestan</i>	<i>14.8</i>	<i>14.7</i>	<i>14.2</i>
<i>The Republic of Ingushetia</i>	<i>30.0</i>	<i>29.3</i>	<i>30.5</i>
<i>Kabardino-Balkarian Republic</i>	<i>24.2</i>	<i>18.1</i>	<i>16.4</i>
<i>Karachay-Cherkess Republic</i>	<i>23.2</i>	<i>22.1</i>	<i>22.0</i>
<i>Republic of North Ossetia-Alania</i>	<i>13.9</i>	<i>13.4</i>	<i>13.0</i>
<i>Chechen Republic</i>	<i>20.4</i>	<i>19.8</i>	<i>19.4</i>
<i>Stavropol region</i>	<i>13.8</i>	<i>13.0</i>	<i>11.7</i>
Volga Federal District federal district (VFD)	13.6	12.8	11.8
Ural federal district (UFD)	11.3	10.9	10.2
Siberian federal district (SFD)	18.1	16.9	16
Far Eastern Federal District (FEFD)	14.6	13.9	12.9

Source [Inequality and poverty. Population with cash incomes below the poverty line (subsistence level) in Russia as a whole and in the constituent entities of the Russian Federation, in % of the total population <https://rosstat.gov.ru/folder/13723>]

Conclusions from Table 3:

1) in the regions of the North Caucasus, the share of poverty is the highest -18.2%, while in the poorest regions, the poverty level has not decreased in three years: in Ingushetia, this indicator fluctuates by 30%, in Karachay-Cherkessia – by 22%, and in the Chechen Republic, the poverty level is higher than 19%;

- 2) the share of the population with monetary incomes below the poverty line both in Russia as a whole and in macro-regions decreased, but it decreased disproportionately, so if in 2020 the poverty level in the North Caucasus was 1.65 times higher than in Russia as a whole, then in 2022 this indicator was 1.86 times higher;
- 3) the share of the population with monetary incomes below the poverty line in the poorest regions, according to 2022, was 2.5-3 times higher than the average in Russia.

Figure 1 shows the dynamics of the poor population, whose incomes are slightly higher than the poverty line, but significantly lower than median incomes. The share of the poor population is also declining, but the size of financial insolvency is still very large, especially among the population of the North Caucasus and Siberia. In the regions of the North Caucasus, the share of the poor population has been and continues to be extremely high: according to 2022, it is 5.3 times higher than in Central Russia, 4.4 times higher than the insolvency of residents of the NWFD and 1.8 times higher than in the also lagging SFD.

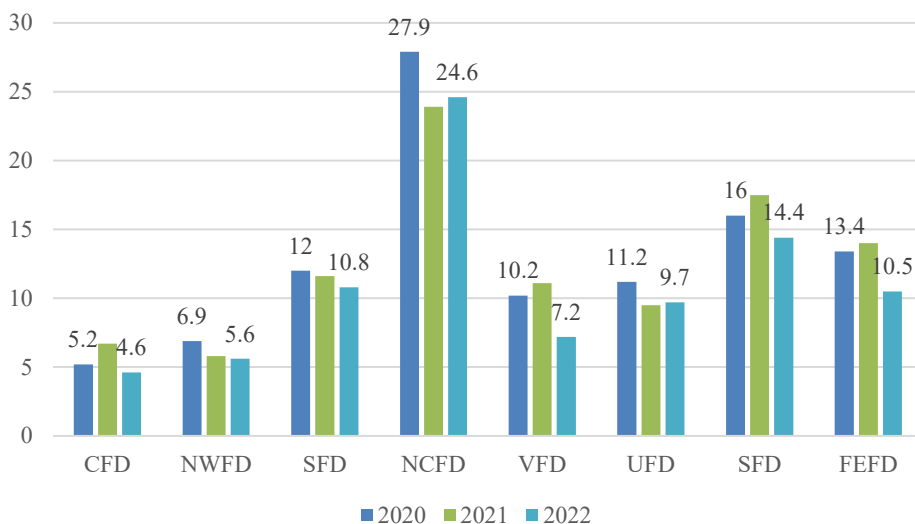


Fig. 1 The share of the poor in the total population of the corresponding group in the regions of Russia in 2020-2022, %

Source [Inequality and poverty. Population with cash incomes below the poverty line (subsistence level) in Russia as a whole and in the constituent entities of the Russian Federation, in % of the total population <https://rosstat.gov.ru/folder/13723>]

Fig. 2 shows the dynamics of informal employment in Russia's regions in 2020-2022, which indicates that the level of informal employment has slightly decreased over the past three years, while in the regions of the North Caucasus, on the contrary, it increased from 42.6% to 43.2%, continuing to be 2-3 times higher than in other regions of Russia.

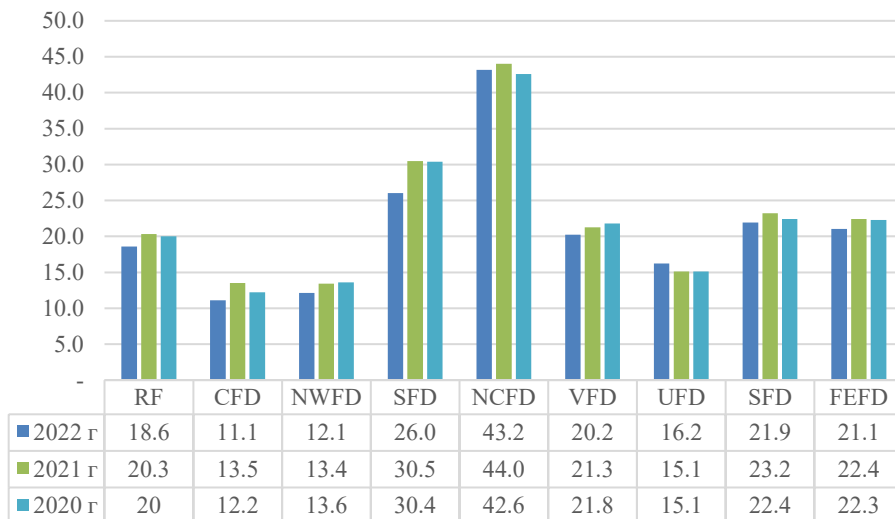


Fig. 2 Dynamics of informal employment in Russian regions in 2020-2022, % of the total employed population

Source [Results of the Labor Force Sample Survey. 2020, 2021, 2022. <https://rosstat.gov.ru/compendium/document/13265>]

Thus, the indicators of the population's income level are closely correlated with the indicators of informal employment. This conclusion is a reliable basis for grouping Russian regions by cluster analysis methods and further development of recommendations for reducing shadow employment in typologically different regions of Russia. The cluster groupings presented in Fig. 3-4 were performed in the RStudio program using the k-means algorithm and Ward's hierarchical method, which allowed to minimize the dispersion within groups. To achieve this goal, z-standardization was initially performed for all variables and then their weighting was performed using t-value regression.

The formed groups of regions according to the criteria "level of GRP per capita - informal employment" and "level of average per capita income - informal employment" indicate a significant impact of regional per capita product and average per capita income on informal employment. As can be seen in Fig. 3, the first cluster (low level of per capita GRP - high informal employment) is formed by five regions of the North Caucasian Federal District and the Republic of Altai; the second cluster, which on the graph closely adjoins the first one in terms of per capita GRP, but demonstrates a slightly lower level of informal employment, includes two regions of the North Caucasian Federal District, the Republic of Buryatia and Krasnodar Krai; the third cluster unites the largest number of RF subjects, informal employment and average per capita GRP here are generally lower than the national average. These three clusters include the vast majority of Russian regions - 77 out of 85. The fourth cluster, with the exception of the Sakhalin Oblast, is formed by regions with per capita GRP above the national average and the lowest informal employment: Moscow, St. Petersburg, Murmansk Oblast, Chukotka and Khanty-Mansi Autonomous Okrug. Finally, the fifth cluster with high per capita GRP and insignificant informal employment is formed by only two subjects of the Russian Federation: the Nenets and Yamalo-Nenets Autonomous Okrugs.

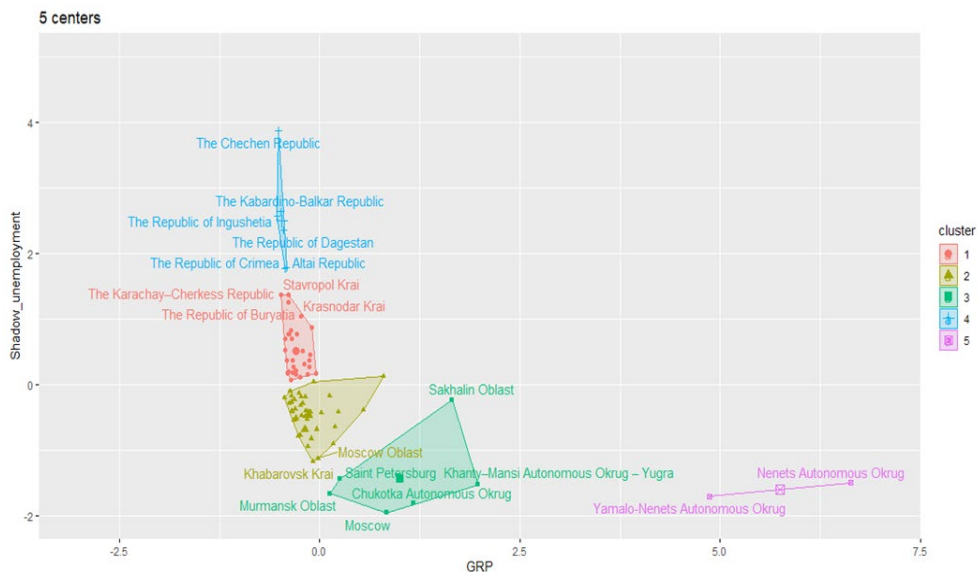


Fig. 3. Clustering of Russian regions by criterion «GRP per capita - informal employment»

Notes: Own calculations, based on Statistics Russia in RStudio.

As can be seen from the grouping of regions in Fig. 4, there is also a clear correlation between the indicators of informal employment and the level of average per capita income in Russian regions.

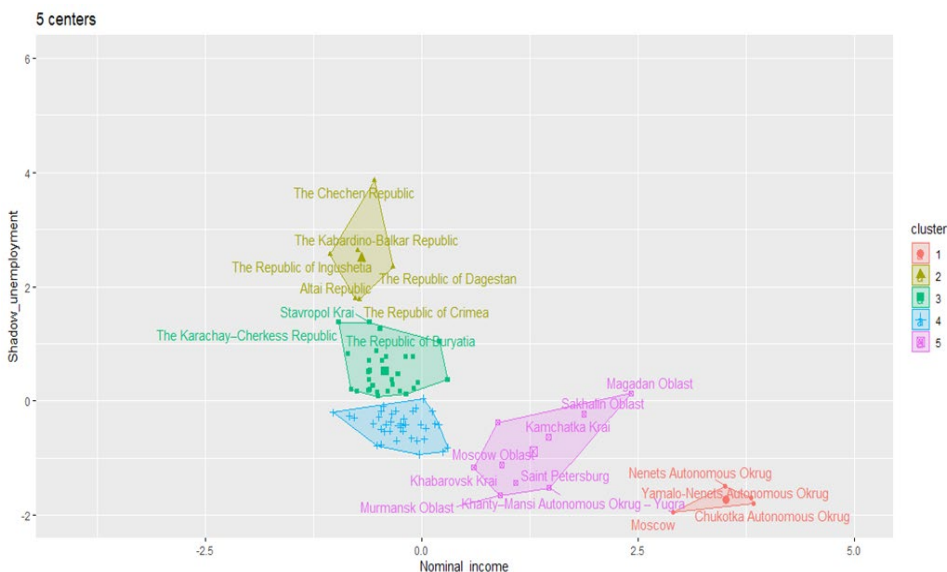


Fig. 4. Clustering of Russian regions according to the criterion «average per capita incomes - the level of informal employment»

Notes: Own calculations, based on Statistics Russia in RStudio.

For the purpose of comparative analysis of the closeness of the relationship between the analysed indicators in the formation of this typology, we also grouped Russian regions into

five clusters. Thus, the group of regions with "low average per capita incomes - high informal employment" includes five subjects of the North Caucasus Federal District and the Altai Republic; the cluster of regions with somewhat higher average per capita incomes and noticeably lower informal employment includes about 30 subjects, with all the regions of the North Caucasus actually forming the lower reference zone. Another 30 or so Russian regions formed a normalised cluster with per capita income and informal employment indicators close to the Russian average. The fourth group includes 8 Russian regions with per capita incomes above the national average. Finally, the fifth cluster includes 4 regions with the highest incomes and the lowest value of informal employment.

To make the spatial location of Russian regions by the criterion "average per capita income of the population - level of informal employment" more clear, Fig. 5 presents a cartography of Russian regions by the level of shadow employment.

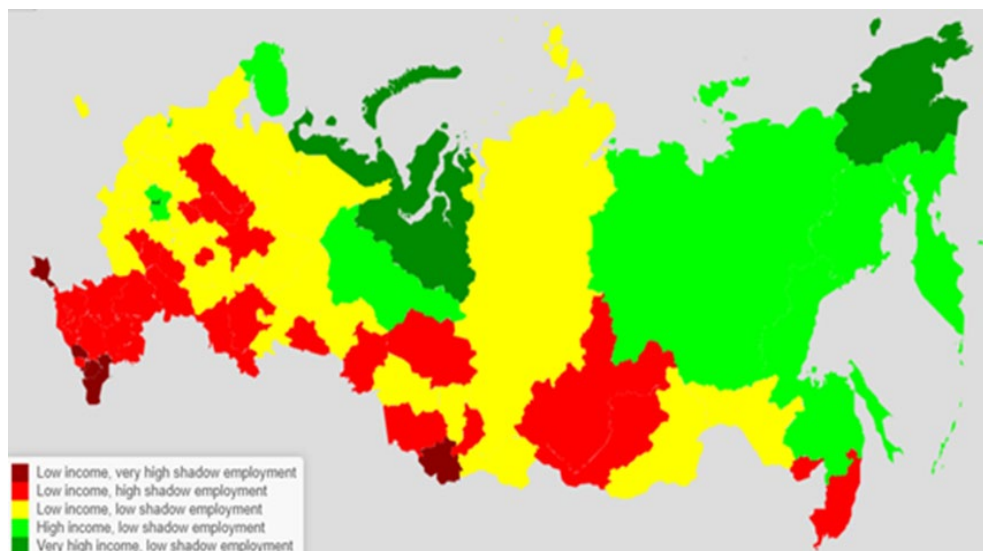


Fig. 5. Map of Russian regions grouped by the criterion «average per capita income - level of informal employment»

Notes: Own calculations, based on Statistics Russia in RStudio.

Fig. 5 clearly shows that the number of “prosperous” regions with very high average per capita incomes and low informal employment in Russia is extremely small. The vast majority of the country's population lives in regions with incomes below the average Russian level and high informal employment, despite the anti-crisis measures implemented by the Russian Government, a significant part of which is aimed at supporting the most vulnerable groups of the population: in 2020, a simplified procedure for registering as unemployed was introduced, the amount of unemployment benefits, the range of persons entitled to these benefits has been expanded. In addition to direct support measures for the population, indirect support measures are practiced, consisting in obtaining a system of preferences and subsidies for enterprises that hire certain categories of personnel.

Mobile work, joint employment, remote work (including platform employment), which the state has been strongly supporting in recent years, have become widespread. In addition, a set of temporary measures was adopted to reduce the administrative and supervisory burden. However, this, as the study showed, is not enough. We believe that in addition to the mechanisms of state control, improvement of legislation in the field of regulation of shadow economic activity, relevant in the regions of Russia are the

modernization of the management system with a focus on the strategic development of human capital through the implementation of basic and specific areas of economic policy aimed at developing the digital economy and creative industries, the proper implementation of federal projects and state programs, all-round support for entrepreneurship, etc. The implementation of a people-oriented national policy should be based on constant regional monitoring of indicators of effective employment (the number of registered and unregistered unemployment; wage levels, the dynamics of legal and illegal migration; small business development; the level of social security of workers and observance of the rights of workers, etc.).

Of course, the achievement of effective employment is determined by the capabilities of the budget system of the Russian Federation, since it directly depends on an increase in the subsistence minimum; the average level of wages; the ratio of the average level of wages with the inclusion of social payments to the subsistence level of the able-bodied population; ensuring the availability of the vital benefits of a working person (primarily housing, health care and education), however, without their implementation, it is not possible to reduce the excessively high informal employment of the population of the regions of the North Caucasus by administrative, regulatory and educational measures. The results of the study allow us to conclude that the growth of labor incomes of the population should become the imperative of the policy of reducing employment in the fairly large shadow sector of the Russian economy.

It should be emphasized that in a constantly changing world, the effectiveness of labor market regulation and the reduction of informal employment also depend on the flexibility of institutional levers and the speed of the state's response to emerging problems, as well as the balanced and appropriateness of certain decisions taken by regional authorities in specific circumstances. At the same time, a qualitative modernization of the employment regulation system in modern realities should be based on the widespread use of blockchain, big data, generated artificial intelligence, and other digital technologies that greatly increase the efficiency of public administration [10, 11].

4 Conclusion

Summing up the results of the work, it is necessary to note the great variety of casual processes leading to the spread of shadow employment, therefore, the problems of reducing its detrimental consequences for the state, regions and population are an area of topical research by economists, sociologists, and politicians.

The hypothesis of the study that informal employment is most preserved in the regions of Russia with low per capita incomes and low GRP per capita has been proven. These include all regions of the North Caucasian Federal District, Altai and Buryatia, which are historically depressive and subsidized according to the budget classification. We emphasize that the identified causal relationships cannot be interpreted unambiguously, since the characteristics of the local labor market can have a specific impact on the structure of the regional economy, and the real scale of informal employment is often masked by part-time employment or unpaid leave.

To reduce the shadow sector of the labor market, first of all, it is necessary to stimulate the creation of jobs with decent wages, promote the employment of socially vulnerable groups of the population, and reduce bureaucratic barriers to the development of small businesses, which are especially at risk of moving into the informal sector. It is necessary to promote in every possible way the development of the digital economy and creative industries, which, due to their innovative nature, have a long-term potential for decent employment for the educated part of the youth. It is necessary to actively expand relatively new forms of employment, which include remote work, platform employment, project

employment with flexible working hours. At the same time, programs for annual wage increases should be introduced in the regions of Russia that are most vulnerable in terms of income of the population, including within the framework of tripartite agreements (the state - the employer - a team of workers), while simultaneously developing a system of social guarantees and social security for the officially employed population. The positive experience of developing countries shows that the proposed system of measures will not only help reduce informal employment, but in the medium term will increase revenues to the country's budget system, reduce the social instability of society by increasing the incomes of most of the 13 million informally employed, and, which is strategically significant in the context of the observed decline in the population of Russia, will create conditions for the demographic development of the country's regions.

In general, the effectiveness of the mechanism of state support for decent employment is ensured not only by a variety of measures, but also by their availability for potential recipients, transparency and speed of distribution of assistance, as well as flexible adjustment of these mechanisms, taking into account the regional characteristics of the functioning of labor markets, the presence of rapid and continuous feedback from members of the economic community. This can be achieved through the widespread use of digital technologies such as data fusion systems and artificial intelligence.

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