Public regulation effectiveness assessment of Russian regional labor markets using hierarchical clustering method

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Abstract. Public employment services (PES) in the modern world play a crucial role in improving the efficiency of the labor market, they reduce the time and effort of the unemployed in finding suitable work, and also reduce information asymmetry and costs for companies in finding the right workers. At the same time, the activities of the employment services themselves have different results, which creates problems with measuring their effectiveness depending on regional characteristics. This article is aimed at developing a more accurate assessment of the effectiveness of PES based on the construction of Russian regions classification. The study is based on the approach of Blien and Hirschenauer (2018), who proposed a new methodology for measuring the effectiveness of PES based on regional clustering. The application of the two-stage method of regression and agglomeration-hierarchical cluster analysis made it possible to rank Russian territories into seven groups of regional clusters. Using R Studio, it was compiled a map of seven clusters of Russian regions. Within each classification group, territories have similar characteristics of labor markets. This study is one of the first attempt to cluster regional labor markets in order to improve the efficiency of the activities of public employment services in Russia. The results of the study can be used by Russian federal and regional executive authorities in the development of an active employment policy in fairly similar territories to achieve greater efficiency of employment services, introduce new services and examples of best practices.

1 Introduction

New approaches to the development and implementation of employment policy are now being updated all over the world. Today's labor markets have been shocked by the crisis due to the unprecedented restrictive measures imposed by governments to contain the spread of coronavirus infection. However, the effects of the pandemic have overlaid different labor challenges in different countries: in European countries, the so-called «double transition» – the greening and digitalization of employment, the demand for highly skilled workers, and radical changes in work organization [1, 2, 3]. On the one hand, the impact of the pandemic

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and digitalization on labor markets is rapidly spreading new technologies used to produce goods and services in emerging countries. On the other hand, this process in those countries leads to a growing polarization of workers and income inequality, an increase in unemployment and informal employment, a decline in the economically active population, etc. [4, 5].

The changes taking place increase the role of the public employment policy, which should correspond to the new realities in the labor markets, reacting flexibly to the changes taking place. As noted by the ILO experts, employment policies are critical not only to mitigate the short-term consequences of the crisis, but also to promote recovery and resilience of the economy and labor markets [6, 7].

In these conditions, the application of universal measures in the development of employment policies «for all», especially in highly differentiated regions, becomes ineffective [8, 9]. There is a need for employment policies that are in line with current realities and regional development patterns [10]. In our study, which is based on the analysis of regional labor markets parameters and results of the policies pursued by public employment services, we tried to substantiate the applicability of new approaches to the evaluation of the effectiveness of labor market institutions based on the clustering of Russian regions.

The Russian labor market is a complex dynamic spatially heterogeneous system. It is characterized by the market infrastructure and its institutions. Public employment services (PES) in Russia play the role of basic infrastructure, they not only offer firms services to find suitable workers and unemployed people to find new jobs, but also perform the functions of social protection of citizens entering the labor market [11]. PES in Russia are coordinated by ROSTRUD, which defines the services to support individuals and firms. These services are at work Russia-wide and therefore each individual and firm can request the same procedures. However, some labour markets work better than others and thus, the efficiency of public employment services may differ between the Russian territories. This does not necessarily mean that the people employed in the PES perform better or worse in a comparison between territories. Differences in efficiency are potentially caused by different initial conditions a territory faces. Russian authors provide evidence for long-lasting regional disparities and, thus, varying initial conditions in Russian territories [8, 11]. For instance, a territory with a higher proportion of employees in the private sector indicates a production and market-oriented industry structure with a potentially more volatile labour demand, leading to a steady flow of firms requesting labour. In a volatile labour market, individuals may lose their jobs more frequently, therefore request PES support, and relatively easy find a new job. This may lead to a seemingly more efficient service of the PES. Contrary, if the private sector in region is relatively less developed, labour demand is potentially rather sticky and unemployed individuals find a new job less easily. Under such conditions, PES may face stronger difficulties to place workers into employment. Thus, initial conditions limit the options for PES, which they cannot change, and are seemingly less efficient [12, 13, 14]. This potential inefficiency, however, is driven by poorer economic conditions.

The problem of assessing the effectiveness of regional employment services, that ensures an active employment policy in the Russian labor market, does not lose its relevance for a fairly long time.

Thus, the development of new approaches to improve the efficiency of public employment services taking into account the regional characteristics of the Russian labor market is an urgent scientific problem. This article is aimed at identifying indicators that reflect the qualitative features of regional labor markets and building a classification of Russian regions for a more accurate assessment of the effectiveness of public employment services based on initial conditions. The hypothesis of the study is the authors's position that regional clusters were historically formed in Russia depending on the economic development in the past, characterized by the situation with unemployment and other factors. The study is

based on the classification method proposed by Blien and Hirschenauer [15]. Identifying regional clusters based on Blien and Hirschenauer's approach facilitates the development of more impactful employment measures at both the federal and regional level. The resulting clusters can provide ROSTRUD and PES with a picture of territories in similar circumstances.

2 Materials and Methods

According to the method of Blien and Hirschenauer, we will sequentially obtain a classification, the purpose of which is to identify clusters of regions that have the most similarity in the initial socio-economic conditions, as this is critical for the functioning of the PES. And only then we will compare the effectiveness of regional public employment services.

As for the initial conditions, it is necessary to find such regional characteristics that can largely explain the differences in the indicators of the effectiveness of state regulation of employment. The hypothesis for the example is that if the GDP is high, people can expect to easily find a new job and therefore they do not request the services provided by the PES. Thus, we expect that the proportion of individuals who will register for PES support will be lower.

For that reason, at the first step, a regression model should be built to identify important regional characteristics that affect the efficiency of the labor market infrastructure. At the second stage, these significant characteristics are used in cluster analysis. Then, in a second step, significant characteristics are used in a cluster analysis. As Blien and Hirschenauer [15] suggest, variables which better explain differences in the performance measure should be more relevant within the cluster analysis. For this reason, all significant characteristics are weighted with the t-value of the regression in the cluster analysis. Finally, a selection of number of groups/clusters has to be chosen. The result of the cluster analysis can eventually be used for a comparison of regions with rather similar initial conditions. Policy measures can be adopted within such groups to increase the overall efficiency of PES. Finally, PES of different regions who belong to the same cluster can learn from each other to improve their individual performance.

We make use of official data from the Russian Statistical Office on Russian territories. Particularly, we have used information for monitoring the socio-economic situation of the Russian Federation individuals (https://www.gks.ru/folder/11109), socio-economic indicators from «Regions of Russia», (https://www.gks.ru/folder/210/document/13204), data included in the appendix to the «Regions of Russia. Socio-economic indicators»(https://www.gks.ru/folder/210/document/47652), and data from «Labor and employment in Russia» (https://www.gks.ru/folder/210/document/13210).

3 Results and Discussion

A descriptive overview of the characteristics under consideration is provided in Table 1. We consider the ratio of individuals requesting support from PES relative to all unemployed individuals as the performance measures that relate to the efficiency of PES. In 82 regions the value does not exceed one and can be then interpreted as a ratio. Accordingly, about 37% of all unemployed request for support by PES. In the regions Karachay-Cherkessia, Nenets Autonomous, and Jewish Autonomous region PES are contacted by less than 5% of all unemployed. On the other site, at least 90% of all unemployed request support by PES in Chechnya, Ingushetia, Moscow, Saint Petersburg, and in Tatarstan.

Table 1. Descriptive Statistics of characteristics.

Characteristics	Mean	Std. Dev.	Min	Max
PES efficiency	0.37	0.63	0.02	4.58
employment rate	58.81	4.64	49.50	75.40
unemployment rate	6.26	3.65	1.30	28.70
proportion of employees…:				
… in private sector	44.47	11.03	9.20	62.6
… in informal sector	5.57	3.27	0.50	20.00
… from foreign countries	8.92	3.45	2.60	17.60
… with lower education	22.44	6.55	7.20	56.70
Average job search duration	7.40	1.27	3.90	11.50

Notes: Own calculations, based on Statistics Russia.

It shows especially rather high values in Siberia and lower values in border regions to the south but also to the east and west. Interestingly, the south-western territories show also higher values but the picture is slightly more mixed. The employment rate varies between 49.5% and 75.4% and is on average 58.8% high. In 2020, the unemployment rate was 6.26% on average with hardly any unemployment in Moscow (1.3%) and high levels of unemployment in Ingushetia (28.7%). Considering the proportion of employees in the private and informal sector shows large variations over Russia. Employment opportunities for individuals from abroad and less-skilled workers vary substantially over the regions, as in Table 1. It takes 7.4 month on average until an unemployed individual finds a new job and usually not longer than one year.

To answer the key question, which initial conditions influence differences in PES success, we performed several regressions to explain the logarithm of the efficiency measure. Table 2 presents the results. In column 1 we present the reference model estimated using OLS with robust standard errors. With more than 38% of explained variance, the model shows a good fit.

Table 2. Regression results of initial conditions on the efficiency measure.

	(1)	(2)	(3)	(4)	(5)
	Reference model	Citizens only	Efficiency measures <=1	Outlier robust	Excluding Moscow
log(GDP per capita)	-0.578**	-0.560**	-0.608**	-0.595**	-0.632***
	(0.247)	(0.263)	(0.245)	(0.227)	(0.229)
employment rate	0.070*	0.071*	0.073**	0.072**	0.079**
	(0.037)	(0.039)	(0.036)	(0.034)	(0.035)
unemployment rate	0.113**	0.103**	0.141***	0.085**	0.125***
	(0.043)	(0.040)	(0.037)	(0.040)	(0.039)
proportion of employees…					
… in private sector	0.061***	0.063***	0.069***	0.064***	0.067***
	(0.014)	(0.013)	(0.012)	(0.012)	(0.013)
… in informal sector	0.105**	0.116**	0.048	0.076**	0.076*
	(0.051)	(0.050)	(0.044)	(0.029)	(0.042)
… from foreign countries	0.090**	0.094***	0.064**	0.042**	0.071**

	(0.036)	(0.035)	(0.028)	(0.019)	(0.030)
… with lower education	0.030	0.028	0.041**	-1.350**	0.048**
	(0.024)	(0.023)	(0.019)	(0.600)	(0.020)
Log (av. job search duration)	-1.684**	-1.794**	-0.885	0.118***	-1.235*
	(0.722)	(0.704)	(0.642)	(0.038)	(0.647)
Constant	-0.372	-0.352	-1.981	-1.099	-1.474
	(3.374)	(3.301)	(3.040)	(2.893)	(3.021)
No. of obs.	85	85	82	85	84
R^2	0.445	0.472	0.429	0.473	0.476
F-Test	7.70***	8.88***	8.78***	9.31***	8.52***

Notes: OLS estimation with robust s.e. in (), column 4 robust regression.

Additionally, all characteristics included explain significantly differences in the efficiency measure jointly. Because especially GDP per capita, the employment rate and unemployment rate are strongly connected by theoretical arguments, some issues of multicollinearity result. However, variance inflation is not a serious problem; variance inflation factors are up to 4.13. The Ramsey test does not provide concerns regarding omitted variables.

Column 2 shows the regression results when the efficiency measure includes only Russian citizens requesting PES support. The results of the reference model (column 1) confirm the expectations. In few cases, the efficiency measure exhibits values larger than one, indicating that more individuals request support by PES than are unemployed (Moscow, St. Petersburg). Excluding these regions provides rather similar results, as shown in column 3. We discuss differences in significance later. Especially the weight assigned to Moscow is 0.25, indicating that Moscow as the capitol is an outlier in a statistical sense. The results are shown in column 4. Lastly, column 5 shows OLS regression excluding Moscow.

Because all models provide rather similar results, we discuss the results more general. Higher values of GDP are associated with lower levels of requested support by PES. This could be due to more complex labour markets and job search behaviour requesting private employment services. The more individuals are employed relative to total population and the higher the unemployment rate is, the more often PES are requested. We expected this, because in both cases, relative more individuals are active at the labour market and potentially look for support. We also provide evidence that a higher proportion of employees in the private and informal sector lead to higher numbers of requested support by PES. Interestingly, the share of people employed in the informal sector becomes insignificant if we exclude only the regions of the North Caucasus, where traditionally the highest informal employment is registered. This insignificance indicates that at least in this regions informal employment is a strategy to avoid unemployment. Less-skilled individuals may look for manual, routine tasks and the PES may offer such jobs more often. As a result, PES are more frequently requested by less-skilled workers and thus, we expect and show such positive relationship. The proportion of foreign employment is positively associated with PES support. Lastly, longer average unemployment duration is associated with less PES support. Here, economic conditions might be too complicated such that PES do not provide many job openings and thus, unemployed may not see any need to register for support by PES.

According to Blien and Hirschenauer [15], all significant initial conditions are used within the proceeding cluster analysis. Each condition (i.e. characteristics) is weighted with its relative importance. As Blien and Hirschenauer suggest, we use the t-value of the regression as weight. The outlier robust estimation (column 4) yields the most plausible estimates and we therefore use the t-values of this model in the proceeding analysis.

All variables under consideration as outlined in Table 2, column 4 significantly explain differences in the performance measure. They are used to group regions with similar initial conditions. As Blien and Hirschenauer, we employ the Ward Cluster procedure which minimizes the within cluster variance. Thus, regions are formed to groups in a way that they are rather homogeneous in its structure. As a result of that, they are valid comparison groups. Because the initial conditions affect the performance measure differently, they are weighted with their relative importance in the Ward Clustering. To achieve this goal, we follow Blien and Hirschenauer and first, perform a z-standardization to all characteristics and then weighted these values with the t-value of the regression. Eventually, the Ward Cluster Analysis is performed using the weighted standardized data.

The Ward Cluster procedure is a hierarchical method. Step by step, one object (or cluster) is added to another object or cluster in a way that the resulting within-group variance is the smallest relative to all other possible assignments of objects or clusters. As a result of that assignment, whenever two objects or clusters are combined, the similarity within each group decreases; or the dissimilarity increases. The procedure has an important implication. Because of the hierarchical approach it happens that an object belongs to a specific cluster but is after all objects are assigned relative close to another cluster. Therefore, a k-Means cluster procedure is suggested to re-assign single objects to the closest group. For this second cluster procedure, the results of the WARD-linkage as starting values. In doing so, the adjustment lead to a re-assignment of 3 regions, indicating an already solid Ward clustering. The k-Means method requests the number of groups, which should be formed, in advance. We tested several groups and decided to present 7 groups as the result of the cluster analysis. The regions that belong to one group are presented in Table 3.

Table 3. Results of the Ward Cluster Procedure: Similar regions.

Group 1	**Moderately developed regions**
No of regions	27
Adygea, Amur region, Arkhangelsk Region without Autonomous, Astrakhan region, Bryansk region, Buryatia, Irkutsk region, Kamchatka territory, Karelia, Khakassia, Kostroma region, Krasnoyarsk region, Kurgan area, Kursk region, Mari El Republic, Mordovia, Murmansk region, Omsk region, Orel, Primorsky Krai, Ryazan region, Saratov region, Smolensk region, Tambov region, The Republic of Komi, Tver region, Volgograd region	
Group 2	**Central regions**
No of regions	22
Altai territory, Bashkortostan, Belgorod region, Chelyabinsk region, Chuvashia, Ivanovo region, Kaliningrad region, Kemerovo region, Kirov region, Krasnodar region, Novgorod region, Novosibirsk region, Orenburg region, Penza region, Perm region, Pskov region, Rostov region, Stavropol territory, Tomsk region, Tyumen region, Ulyanovsk region, Voronezh region	
Group 3	**Subcentral regions**
No of regions	14
Kaluga region, Khabarovsk territory, Leningrad region, Lipetsk region, Moscow oblast, Nizhny Novgorod region, Samara region, Sverdlovsk region, Tatarstan, Tula region, Udmurtia, Vladimir region, Vologda region, Yaroslavl region	
Group 4	**The cold regions**
No of regions	5
Chukotka Autonomous Okrug, Magadan region, Nenets Autonomous district, Sakhalin region, Yakutia	
Group 5	**Metropolitan cities and Oil**
No of regions	4
Moscow, Saint-Petersburg, Khanty-Mansi Autonomous District-Yugra, Yamalo-Nenets Autonomous District	

Group 6	**The Periphery**
No of regions	8
Jewish Autonomous region, Kalmykia, Karachay-Cherkessia, North Ossetia, The Republic Of Altai, Tuva, Zabaikalsky Krai, Kabardino balkaria	
Group 7	**Caucasian regions**
No of regions	3
Chechnya, Dagestan, Ingushetia	

Finally, using the R Studio seven clusters are spatially visualized in Fig. **1**. Map of Russian regions depending on their belonging to the cluster.

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Fig. 1. Map of Russian regions depending on their belonging to the cluster.

There are some interesting observations that are worth to note. The largest groups 1, 2 and 3 cover about two third of all regions. When they are grouped into one group, the dissimilarity does not increase much, indicating that the regions included feature rather similar initial conditions. A consolidation of Groups 4 and 5 would also lead to a relative low increase in dissimilarity. The same applies for Groups 6 and 7. However, very different to remaining Russia are groups 6 and 7. They show very distinct values of initial conditions at the labour market. Whereas an aggregation of all regions of Groups 1 to 5 would yield a moderate increase in dissimilarity. The dissimilarity increases substantially, if we add the regions of group 6 and 7 to all regions included in groups 1 to 5. With respect to content, policy programs that may work in other regions may not be appropriate for the regions included in group 6 and 7.

Focussing on group 5 shows that, firstly, Moscow and St. Petersburg show rather similar initial conditions and they become later combined with two Siberian states which are characterized by high employment levels, low unemployment and high GDP per capita (explained by the extraction of oil and gas). However, both subgroups (the two large cities vs high-profit gasoline industry) are very dissimilar to each other. The next step of aggregation will combine Group 5 with Group 4. Because Group 4 considers mainly northern, «cold» regions, they show rather similarities with the oil-regions.

Table 4 presents a descriptive summary of initial conditions reflecting labour market related indicators.

Table 4. Average initial conditions (within clusters).

G	**E**	**U**	**G**	**Proportion of employees:**

				in private sector	In informal sector	From foreign countries	with lower education
1	57.32	6.05	411.70	43.65	4.80	8.43	21.31
2	57.97	5.23	399.20	53.37	5.48	7.49	22.59
3	60.55	4.33	487.90	49.76	4.16	13.66	20.62
4	66.94	5.74	2651.30	36.66	3.72	12.28	23.72
5	69.53	1.88	2648.80	57.40	2.20	12.10	12.48
6	54.91	11.48	235.60	24.31	8.81	5.84	25.92
7	54.70	18.23	149.80	16.13	18.10	3.73	44.43

As can be seen, group 7 is characterized by low employment levels and high unemployment. Additionally, the proportion of employees within the informal sector is relatively high, associated with a higher share of less-qualified workers. Finally, GDP per capita and the proportion of foreigners are low. Group 6, in comparison, shows slightly better conditions which are, still, relatively poor compared to the other groups. Some differences can be seen between Group 1 and 2, but they are rather small. In contrast, the regions included in Group 3 are characterized by higher income and a higher share of foreigners. Thus, they are more attractive for immigration. Groups 4 and 5 are the most productive regions. As can be seen, for instance active labour market policies for individuals of lower education might be more successful in regions with higher proportions of less-skilled workers. Insofar, the metropolitan-oil group 5 does not need that much support.

The labour market oriented classification (considering 7 groups) differs from the classification of Economic Zones. Most importantly, the dissimilarity between the groups 1 to 5 are not so large. Apparently, when comparing Table 4 with Figure 4 we cannot see a clear East-West division for our classification. There is additionally a North-South difference in labour market characteristics and fewer dissimilarities in the European part of Russia. With respect to content, using the Russian Economic Zones as reference to adopt best practice examples and to apply labour market oriented PES improvements would be less efficient. Therefore, the economic zones show some similarities with the labour market oriented classification, but not entirely; especially when the focus is set on improving PES.

The main limitation of our analysis is the rough classification of regions and therefore, within each region the heterogeneity in initial conditions may differ still substantially. We have shown, that such first classification provides first evidence that labour-market oriented classification schemes do not necessarily reflect the Russian Economic zones. However, more disaggregated data is needed to provide further insights into similarities and differences between regions in labour market characteristics, which lead to better/ worse performing PES.

4 Conclusion

Public Employment Services (PES) provide support for firms and individuals in finding new employment opportunities, they are therefore important actors at the labour market. Using the Blien and Hirschenauer fuzzy clustering method, we identified seven different clusters of Russian regions. Within each cluster, there are many similarities in the characteristics of the labor market, and therefore the same efficiency of PES can be expected. Between clusters, the initial characteristics of the labor market differ, so the comparison is incorrect. Thus, our hypothesis is confirmed that there are regions with different historical stages of (economic) development and territories should be classified into groups showing similarities. Compared to Russian economic regions, we show that the labor market-oriented classification paints a

clear picture. For this reason, improving the efficiency of PES and the introduction of best practices should be considered in relation to the regions included in the same cluster. That is, PES who want to improve their services and quality can compare themselves and learn from other PES in the same cluster. Our clustering is the first step towards a regional classification of labor markets that have similarities. However, more disaggregated data are needed to get a more detailed picture. However, the study provides a clear indication of which regions can implement PES-related policies and which regions have (dissimilar) labor markets.

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