



# Evaluating the impact of border in managing a municipal unit by using hierarchical analysis methods

## Evaluar el impacto fronterizo en gestión de una unidad municipal mediante el uso de métodos de análisis jerárquico

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#### ABSTRACT:

The heterogeneity of the economic space is often found in the differences related to the development of central regions and areas located along borders. In this paper the authors have made an attempt to quantify the impact of the location of a municipal unit (MU) near the borders of the Russian subject and its hierarchical subordination on its socio-economic state. For this purpose, the tools used in the hierarchical analysis, including those in other scientific areas, and allowing to analyze group and intergroup relations (HLM - Hierarchical linear modeling) were applied. The groups have been singled out according to belonging of the MU to a Russian subject and its location (in the center or at the border of the subject). In the paper 334 MU located in seven subjects (regions) have been analyzed. One hundred and ninety-four of them are located on the territory with an interregional border. The obtained results generally indicate the applicability of these tools in spatial analysis. The calculations made it possible to define the impact of the location on the achieved values of the indicators and quantify its importance. In the course of the data analysis, it has been determined that the location and hierarchical

#### RESUMEN:

La heterogeneidad del espacio económico se encuentra a menudo en las diferencias relacionadas con el desarrollo de las regiones centrales y las áreas ubicadas a lo largo de las fronteras. En este artículo, los autores intentaron cuantificar el impacto de la ubicación de una unidad municipal (MU) cerca de las fronteras del sujeto ruso y su subordinación jerárquica en su estado socioeconómico. Para este propósito, se aplicaron las herramientas utilizadas en el análisis jerárquico, incluidas las de otras áreas científicas, y que permiten analizar las relaciones de grupo e intergrupo (HLM - modelado lineal jerárquico). Los grupos se han destacado de acuerdo con la pertenencia de la MU a un sujeto ruso y su ubicación (en el centro o en el borde del sujeto). En el documento se han analizado 334 MU ubicadas en siete temas (regiones). Ciento noventa y cuatro de ellos se encuentran en el territorio con una frontera interregional. Los resultados obtenidos generalmente indican la aplicabilidad de estas herramientas en el análisis espacial. Los cálculos permitieron definir el impacto de la ubicación en los valores alcanzados de los indicadores y cuantificar su importancia. En el curso del análisis de datos, se ha determinado que la

subordination of the MU have a different degree of impact on various indicators.

**Keywords:** municipal unit, border, management hierarchy, spatial analysis, multilevel modeling, spatial connection, group dispersion, intergroup dispersion, hierarchical linear model (HLM), regional economy.

ubicación y la subordinación jerárquica de la UM tienen un grado diferente de impacto en varios indicadores.

**Palabras clave:** unidad municipal, frontera, jerarquía de gestión, análisis espacial, modelado multinivel, conexión espacial, dispersión grupal, dispersión intergrupala, modelo lineal jerárquico (HLM), economía regional.

## 1. Introduction

The external differentiation of territories and internal inequality of their development are the two most frequently raised problems in the regional economy. This is due to the fact that the socio-economic situation of both regions and individual settlements located in them varies at different rates under the impact of various factors. These two problems are rarely considered comprehensively. As a rule, when the differentiation of regions and countries is studied, their advantages and disadvantages are compared. In case of analyzing internal inequality, the causes and factors of its occurrence are compared.

At the same time, a center and periphery can be distinguished within any territorial unit (a settlement, a city, an area, a region, a region-subject, a district, etc.). In accordance with natural causes challenged by a higher population density, the most active socio-economic development is observed in central parts of the territories. The periphery is usually located on the border of a territorial unit and horizontally interacts with the periphery of the neighboring territorial unit (Erkut & Özgen, 2003). As a rule, the current studies touch the problems on the cooperation in the border areas of different countries in order to improve the connectivity of the territories (Gualini, 2003; Perkmann, 2003; Decoville et al., 2013; Chilla et al., 2012; Fomin, 2010). In the countries with large territories, such studies aim at studying the effect of the interregional border (Dube et al., 2010; Lukin & Uskova, 2016; Nitsch, 2003).

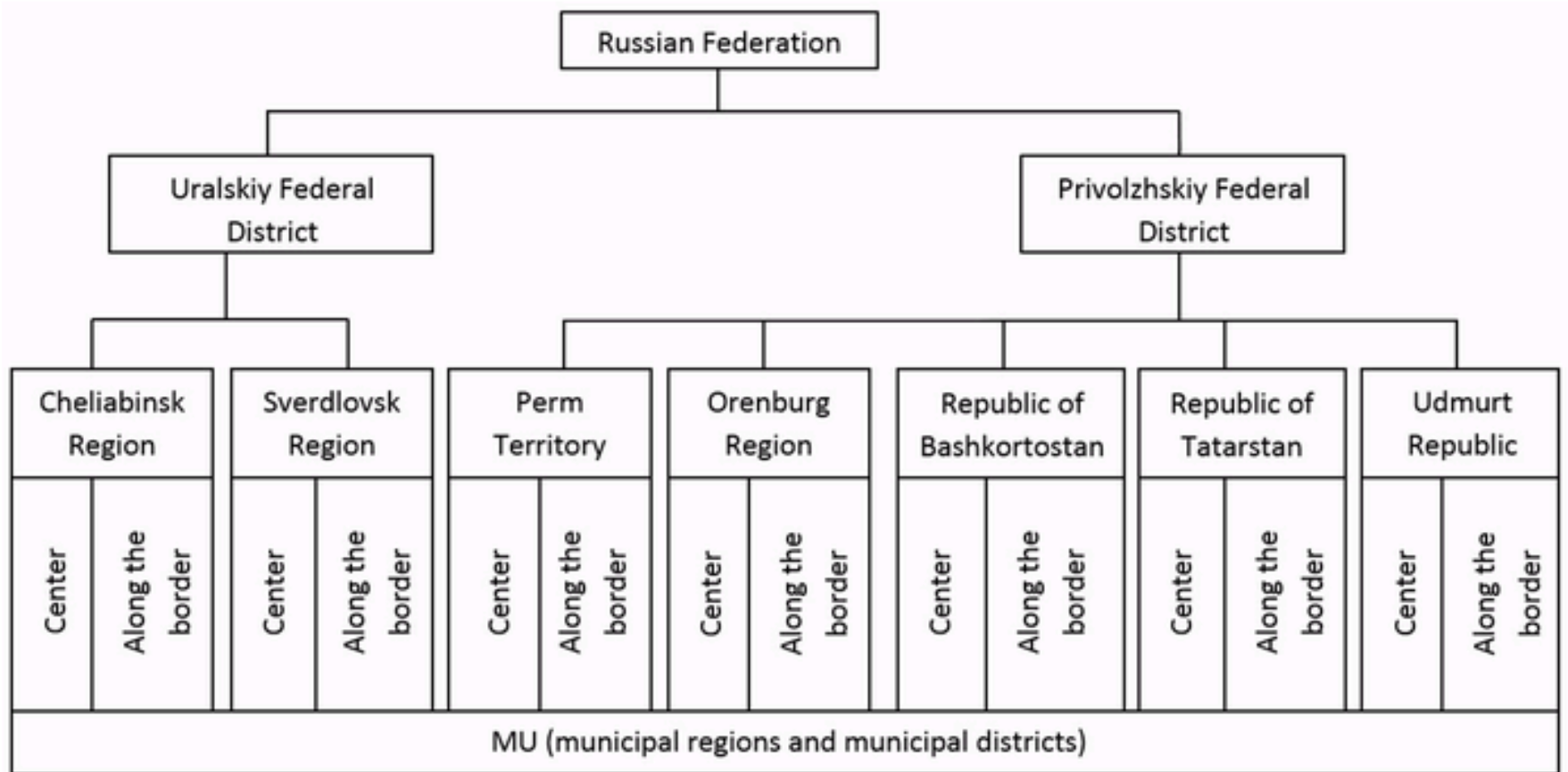
This study aims at expanding ideas about the development of the MU located along the borders and in the center of the subjects of the Russian Federation. It is based on applying the tools that until recently have been used in other scientific areas to assess intergroup and interclass differences. The effect of the territory location along the border or in the center to achieve certain results can be defined by using multilevel hierarchical analysis due to including a categorical variable that is responsible for belonging of the MU to the territory with an interregional border. The study of interregional differences at the level of MU, taking into account their spatial location, will allow more reasonably expanding the interregional cooperation and improving the connectivity of the territory.

## 2. Logics and methods

The study of the impact of the MU location on its development must take into account rather many factors. In this paper, only two factors are taken into account: the location in regard to borders and the hierarchical subordination to one of the Russian subjects. In order to be able to take into account the location in regard to interregional borders, all MU within each Russian subject were divided into two groups. The first one included the MU located in the central part, and the second group included those located on the periphery, on the border with other subjects of the Russian Federation. This classification makes it possible to form a hierarchical structure of the territory under study.

**Figure 1**

Hierarchical structure of the territory under consideration



The offered formulation of the problem allows applying the multilevel analysis methods to evaluate the impact of the group effect and the MU location on their development. Singling out the hierarchical subordination of MU by their location in regard to interregional borders of the Russian subjects as a separate level is an artificial formation of groups. The results of such grouping can be quite controversial, and the obtained results must be widely discussed. However, they are required for determining the possible boundary effect by using hierarchical analysis tools.

At the first stage, the hypothesis about the intergroup differentiation, i.e. differences among the MU in the achieved values of indicators depending on the location (center/along the border) and belonging to a particular Russian subject was tested. In order to do this, average values and variations of the indicators of the socio-economic development in the MU through the example of seven constituent entities of the Russian Federation were calculated. After that, the authors used the approach of H. Moellering and W. Tobler (Moellering & Tobler, 1972) who had noted that the geographical hierarchy had been ordered by the size of the areas that could have been taken as a scale unit. According to them, the data analysis at different levels of the hierarchy is equivalent to the data analysis at different geographic scales. When applying this approach, it is necessary to take into account the fact that the current division of territories is far from the ideal structure offered by V. Christaller. The results obtained on the impact of each level should be interpreted with a great caution due to the heterogeneity of the data of the nested structure. In addition, there are clear requirements for the hierarchy under analysis. Firstly, the hierarchy must be fully nested (i.e. the MU may belong to only one subject of the Russian Federation). Secondly, the branches in the hierarchy must be of the same length for each MU. Thirdly, "local inversions" are not allowed in the hierarchical tree.

At the second stage, the hypothesis that the value of the indicator is determined by the effects on three levels was tested:

$$X_{ijk} = \bar{X} + a_i + b_j + c_k, \quad (1)$$

where  $X_{ijk}$  is the value of the indicator in the  $k$  MU (where  $k=1..n$ ) included in the subject of the Russian Federation  $i$ ,

$\bar{X}$  is the average value of the entire aggregate under analysis, where 
$$\bar{X} = \frac{\sum_i \sum_j \sum_k X_{ijk}}{n}$$

$a_i$  is the effect determined by the region-subject of the Russian Federation  $i$  ( $i = 1..m$ ), where  $a_i = \bar{X}_i - \bar{X}$

$b_j$  is the effect determined by the location of the MU in regard to the borders of the region  $j = \begin{cases} 1, \text{center} \\ 0, \text{along the border} \end{cases}$ , where  $b_j = \bar{X}_j - \bar{X}_i$ , and

$c_k$  is the effect determined by the MU  $k$ , where  $c_k = X_{ijk} - \bar{X}_j$ .

The average values can be determined for each level separately. The transformation (1) makes it possible to analyze the deviation of the actual values from the average ones for each object at each level of the hierarchy by using the following formula:

$$X_{ijk} - \bar{X} = (\bar{X}_i - \bar{X}) + (\bar{X}_j - \bar{X}_i) + (X_{ijk} - \bar{X}_j). \quad (2)$$

Thus, the deviation from the average can be considered in the context of three levels. The further analysis involves the calculation within these three levels of squared deviations and the determination of the share of certain levels in the observed deviation:

$$\begin{aligned} \sum_{i=1}^m \sum_{j=1}^p \sum_{k=1}^n (X_{ijk} - \bar{X})^2 &= \sum_{i=1}^m \sum_{j=1}^p \sum_{k=1}^n (\bar{X}_i - \bar{X})^2 + \\ \sum_{i=1}^m \sum_{j=1}^p \sum_{k=1}^n (\bar{X}_j - \bar{X}_i)^2 &+ \sum_{i=1}^m \sum_{j=1}^p \sum_{k=1}^n (X_{ijk} - \bar{X}_j)^2. \end{aligned} \quad (3)$$

The hierarchical (three-level, nested) nature of the data allows applying hierarchical linear modeling. In recent years, such models have been actively used in the analysis (Goldstein, 2010; Garson, 2013; Khalikova & Lackman, 2015; Yusupov, K.N. et al., 2018), including in the regional economy (Yannis et al., 2007; Srholec, 2010). In this regard, the evaluation of the impact of the location of the MU in regard to the interregional border on its development extends possible areas of applying this tool.

Within this work, a two-level hierarchical model of the Random intercepts class was formed. The introduced categorical variable  $CB_{ij}$ , which accepts two variants of values: 1 (in case the MU is located near the interregional border) or 0 (in case the MU does not have an interregional border), helps to link the indicator change with the location of the MU in regard to the interregional boundary:

Level 1 (lower):

$$X_{ij} = \beta_{0j} + \beta_{1j} * (CB_{ij}) + r_{ij}, \quad (4)$$

Level 2 (upper):

$$\beta_{0j} = \gamma_{00} + u_{0j}, \quad (5)$$

$$\beta_{1j} = \gamma_{10}. \quad (6)$$

This is the general view of the model combined at both levels:

$$X_{ij} = \gamma_{00} + \gamma_{10} * CB_{ij} + u_{0j} + r_{ij}, \quad (7)$$

where  $X_{ij}$  is the indicator characterizing the socio-economic situation of the  $i$  MU of the  $j$  region of the Russian Federation, thous. RUB.

$CB_{ij}$  is the categorical variable reflecting the location of the MU in regard to the borders of the Russian subject, and taking the value 1 if it is located along the borders, and 0 in the opposite situation,

$\beta_{0j}$  is the function of the total free term ( $\gamma_{00}$ ) and the error of interregional dispersion ( $u_{0j}$ ),

$\beta_{1j}$  is the linear slope of the regressor;  $CB_{ij}$  is the constant  $\gamma_{10}$ ,

$r_{ij}$  is the error of regional (intermunicipal) dispersion,

$j$  is the index that is responsible for belonging to a certain subject of the Russian Federation ( $j = 1, 2, \dots, 7$ ), and

$i$  is the index that is responsible for belonging to a certain MU ( $i = 1, 2, \dots, 334$ ).

As a whole, the inclusion of categorical variables in various types of regression models is not new, and previously this approach was used to evaluate the effect of the boundary in variations of various indicators (Engel & Rogers, 1996; Requena & Llano, 2010; Borraz et al., 2015). In this study, such categorical variable is included in the HLM. The hierarchical analysis evaluated how considerably the intergroup dispersion differed from zero. To do this, the model was formed without including the variation on the absolute term, and the dispersion analysis was made to compare the models among themselves. If there is a statistically considerable difference between the models, the intergroup dispersion is non-zero, otherwise the difference is considered inconsiderable. To test the relevant hypothesis, an intraclass correlation coefficient (ICC) is used:

$$ICC = \frac{\sigma_{00}^2}{\sigma_{00}^2 + \sigma_j^2} \quad (8)$$

where  $\sigma_{00}$  is the interregional dispersion,

$\sigma_j$  is the intraregional (intermunicipal) dispersion.

This coefficient shows what part of the total dispersion can be explained by varying the average in the groups (in this study, in the subjects of the Russian Federation), i.e. to evaluate the impact of the region on the development of MU. The value of the coefficient ranges from +1 (in the situation when the variation is determined directly by

the difference between the groups under no variation within the groups) to  $\frac{1}{(n-1)}$  (when the variation is mainly intragroup (where  $n$  is the number of MU)). The value of the coefficient that is close to zero indicates that the upper level of the management hierarchy does not affect the development of lower level objects, in the particular case, MU. In the work of V. Huta it is noted that if ICC is less than 5 %, it is not reasonable to form hierarchical models (Huta, 2014). The statistical importance of the model and, as a consequence, the verification of the hypothesis about the feasibility of using the tools of hierarchical modeling were tested by using the  $\chi^2$  criterion defined for random effects, when testing the null hypothesis about the lack of group effects (Raudenbush, 1993).

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### 3. Analyzing the achieved values of indicators for the mu located in adjacent territories

In their work the authors used the indicators of 334 MU located in seven subjects (regions) belonging to two federal districts of the Russian Federation. One hundred and ninety-four of them were referred to as the MU located on the territory that contains an interregional border. The analysis excluded the closed cities because of the peculiarities of their development and the lack of data on some indicators.

Seven out of 85 subjects of the Russian Federation under consideration are characterized by the conditional border between the European and Asian parts of the country. Their total area is 819.6 thousand km<sup>2</sup>. In these seven subjects of the Russian Federation there are 21.9 million people, which is almost 14.9 % of the total population of the country. In ratings three of seven regions under analysis are often found in top ten of the best subjects of the Russian Federation.

Three indicators were analyzed for the subjects of the Russian Federation under consideration:

- Social payments and taxable money income of the population on average per one resident of the MU in 2016, thous. RUB/person,
- Shipped goods produced locally, performed works and services by own efforts (excluding small entrepreneurship) as per one person in the MU in 2016, thous. RUB/person,
- Investments in fixed capital (excluding budgetary funds) per one person in 2016, thous. RUB/person.

The values of the indicators collected by the Federal State Statistics Service correlate with the indicators most often used to evaluate the socio-economic development of a territory. The first indicator characterizes the standard of living, the second – the production

development, and the third – the investment activity of MU. These three aspects are most often analyzed when studying the development of territories (Sinelnikov-Murylev, 2017) and are taken into account in the ratings of Russian subjects (Rating of socio-economic status of subjects of the Russian Federation according to the results of 2017).

The presented average values and variation of indicators in the context of the subjects of the Russian Federation, singling out the peculiarities of the indicator in the MU located on the contact line with a neighboring subject of the Russian Federation, clearly distinguish the following feature: the MU located in adjacent territories have lower value of the indicator.

**Table 1**  
Indicators as calculated per one resident  
of the mu in 2016, thous. Rub/person

Item		Cheliabinsk Region	Sverdlovsk Region	Republic of Bashkortan	Perm Territory	Orenburg Region	Republic of Tatarstan	Udmurt Republic	
Social payments and taxable money income of the population	Minimum value	109.05	125.84	97.44	100.9	103.06	116.1	120.2	
	Maximum value	394.4	422.2	321.0	348.9	246.1	404.0	291.3	
	Average	Total	175.4						
		In region	182.3	205.4	143.2	172.9	161.6	190.0	163.8
		Including in the areas located in the central part	202.0	209.1	151.0	190.1	178.0	222.4	194.7
		In the areas located in the border	171.7	199.7	134.8	155.0	150.6	168.4	152.6
	Variation, %	Total	31.8						
		In region	35.8	27.3	30.6	30.1	23.0	31.8	21.0
		Including in the areas located in the central part	31.4	29.8	33.7	32.9	19.5	34.8	21.8
		In the areas located in the border	37.1	22.1	24.1	18.5	23.9	18.1	14.3
Shipped goods produced locally, performed works and services by own efforts	Minimum value	7.4	4.7	11.9	8.3	16.9	36.0	17.4	
	Maximum value	1,098	2,749	1,332	2,649	2,625	2,818	1,675	
	Average	Total	290.6						
		In region	278.2	345.4	142.1	374.7	222.4	387.4	306.2
		Including in the areas located in the central part	383.5	421.7	192.1	460.2	348.5	627.8	412.1
		In the areas located in the border	219.2	226.7	88.8	285.5	136.6	227.1	267.7
	Variation, %	Total	148.2						
		In region	96.4	152.8	150.2	129.2	192.9	129.2	126.9
		Including in the areas located in the central part	65.4	149.3	139.9	120.7	174.0	108.3	48.1
		In the areas located in the border	118.4	118.0	121.1	131.7	148.6	93.3	161.2
y funds)	Minimum value	0,19	0.16	0.09	0.05	0.06	1.37	0.38	
	Maximum value	269,9	460.1	379.1	2377.8	312.4	364.9	45.6	

Investments in fixed capital (excluding budgetary	Average	Total	36.1						
		In region	23.1	35.0	22.2	70.5	26.9	55.8	11.9
		Including in the areas located in the central part	40.0	44.7	28.7	127.5	46.0	85.2	17.7
		In the areas located in the border	14.2	19.9	15.2	8.5	14.0	36.2	9.8
	Variation, %	Total	388.6						
		In region	198.1	190.9	244.8	480.7	194.2	133.3	92.0
		Including in the areas located in the central part	171.9	180.2	236.4	362.3	160.2	117.6	78.8
		In the areas located in the border	154.5	155.3	216.4	115.3	158.1	109.4	88.9

The analysis of the average values showed the differentiation of the MU in the context of the subjects of the Russian Federation. The MU located on the border between subjects of the Russian Federation are quite far behind as compared to the MU located in the center by the achievable values of indicators. At the same time, the variation of the indicators in the MU located on the interregional border may be stronger than the variation of the MU located in the center. This is largely determined by the differences imposed by the MU located on the other side of the interregional border, and controlled by another subject of the Russian Federation.

The regional power within the general vector of development determined by the national power makes decisions that make it possible to most efficiently use the existing potential of the territories. The development of each local area (MU) depends on the way they explain the general concept of the federal government to a lower level of government (municipal, local) and link it with the capabilities of the region. However, Jing Pan notes that "higher level policies can be possibly interpreted into a locally differentiated version upon local government's discretion and objectives and hence be implemented differently" (Pan, 2014). Thus, the regional authorities can not only implement various activities, but also conduct the same activities differently. As a consequence, the MU managed by different subjects of the federation may have different tasks and development programs. The neighborhood of such MU divided by a conditional border between the subjects of the Russian Federation, influencing their development, may determine their higher variation in comparison with the MU located in the central part.

## 4. Results

According to the method of H. Moellering and V. Tobler (1972), the impact of the regional power and belonging of the MU to the territory containing the interregional border on the values of indicators achieved by them was evaluated. The most important gap is observed between the MU located in the central part and on the periphery of the subject of the Russian Federation in terms of the shipped products and investments in fixed assets in the Republic of Tatarstan and the Sverdlovsk Region. Even though the values of indicators in the adjacent territory of these subjects of the Russian Federation are higher than those of their neighbors, the central part develops several times better. Thus, on average, in the Republic of Tatarstan, in the districts located in the central part, the volume of products shipped per capita is 627.8 thous. RUB/person, and in the areas that are adjacent to other regions of the Russian Federation this is 227.1 thous. RUB/person. At the same time, the value of the indicator in the adjacent territories of two neighboring subjects of the Russian Federation is even lower (in the Republic of Bashkortostan – 88.8 thous. RUB/person, and in the Orenburg Region – 136.6 thous. RUB/person).

In order to determine the importance of the impact of the location and hierarchical subordination on the socio-economic development of the MU, the sum of squared deviations of indicators for the MU from the average one by all three indicators was determined. The greatest variation is observed at the level of the MU. For the indicator "Investments in fixed

assets”, the location (center/ along the border) is practically unimportant. On the contrary, the variation of social payments and taxable money income of the population on average per one resident of the MU is determined by 14.4 % by the subject of the Russian Federation and by 7.4 % by its location: in the central part or along the interregional border.

**Table 2**  
Sum of squared deviation in terms of singled out levels

Item		Level			
		total	subjects of the Russian Federation	center/ along the border	MU
		0	1	2	3
Social payments and taxable money income of the population on average per one resident of the MU in 2016	Sum of squared deviation from the average, thous. RUB/person	$3.1 \cdot 10^3$	$4.5 \cdot 10^2$	$2.3 \cdot 10^2$	$2.4 \cdot 10^3$
	share, %	100	14.4	7.4	78.1
Shipped goods produced locally, performed works and services by own efforts as per one person in the MU in 2016	Sum of squared deviation from the average, thous. RUB/person	$1.8 \cdot 10^5$	$7.6 \cdot 10^3$	$1.1 \cdot 10^4$	$1.7 \cdot 10^5$
	share, %	100	4.1	6.0	89.9
Investments in fixed capital (excluding budgetary funds) per one person in 2016	Sum of squared deviation from the average, thous. RUB/person	$1.96 \cdot 10^4$	$3.4 \cdot 10^2$	$6.7 \cdot 10^2$	$1.86 \cdot 10^4$
	share, %	100	1.7	3.4	94.8

In order to confirm the hypothesis about the impact of the location on the achieved values of the indicators, hierarchical linear models were made. The results of the calculations confirmed the hypothesis about the importance of the impact of the boundary for the indicators “Social payments and taxable money income of the population on average per one resident of the MU” and “Shipped goods produced locally, performed works and services by own efforts as per one person in the MU”. The p-value values are above 0.5, and the low rate of likelihood for the indicator “Investment in fixed assets (excluding budgetary funds) per one person” indicates that there is no impact of the interregional border on it.

**Table 3**  
Results of forming HLM



Item	Reliability estimation	Variance Component ( $\sigma^2$ )	$\chi^2$	p-value	ICC
<b>Social payments and taxable money income of the population on average per one resident of the MU</b>					
Level1 coefficient, $\beta_0$	0.871				
Error in the intragroup dispersion, e		2320.3			86.9
Error in the intergroup dispersion taking into account belonging to the Russian subject, $r_0$		348.4	59.0	<0.001	13.1
<b>Shipped goods produced locally, performed works and services by own efforts as per one person in the MU</b>					
Level 2 coefficient, $\beta_0$	0.586				
Error in the intragroup dispersion, e		172,864.1			96.99
Error in the intergroup dispersion taking into account belonging to the Russian subject, $r_0$		5,359.7	15.1	0.019	3.01
<b>Investments in fixed capital (excluding budgetary funds) per one person</b>					
Level 2 coefficient, $\beta_0$	0.037				
Error in the intragroup dispersion, e		19,391.4			99.9
Error in the intergroup dispersion taking into account belonging to the Russian subject, $r_n$		15.5	5.6	>0.500	0.1

For the indicator "Social payments and taxable money income of the population on average per one resident of the MU" belonging to one of the seven Russian subjects determines 13.1 % of the variation of the indicator, and this is 3.01 % for the indicator "Shipped goods produced locally, performed works and services by own efforts as per one person in the MU".

The model included the categorical variable "border (CB, cross-border)" that within the multilevel linear regression showed the impact of belonging of the MU to the territory containing the intermunicipal border on the indicator variation. Table 4 shows the evaluation of fixed effects for this variable.

**Table 4**  
Final estimation of fixed effects with robust standard errors

Fixed effect	Coefficient	Standard error	t-ratio	Approx. d.f.	p-value
<b>Social payments and taxable money income of the population on average per one resident of the MU</b>					
For INTRCPT1, $\beta_0$					
INTRCPT2, $\gamma_{00}$	186.4	8.17	22.79	6	<0.001
For CB slope, $\beta_1$					
INTRCPT2, $\gamma_{10}$	-25.3	5.8	-4.36	325	<0.001
<b>Shipped goods produced locally, performed works and services by own efforts as per one person in the MU</b>					
For INTRCPT1, $\beta_0$					
INTRCPT2, $\gamma_{00}$	401.5	49.18	8.16	6	<0.001
For CB slope, $\beta_1$					
INTRCPT2, $\gamma_{10}$	-195.9	34.57	-5.66	325	<0.001

The negative value of the coefficients  $\gamma_{10}$  under the categorical variable CB<sub>ij</sub> in both models indicates the negative impact of the location of the MU along the borders of the Russian subject on the achieved values of the indicators. Accordingly, the location in the center contributes to obtaining higher values of indicators of the socio-economic development of the MU.

## 5. Discussion

The space heterogeneity is determined by many factors. This study focuses on identifying differences in the development of the MU located along the interregional border and those located in the center of the region as well as defining the importance of the interregional boundary in the detected heterogeneity of the territory under these conditions. The differences in the development of territories located along borders are found in many countries (Dube et al., 2010). It is often noted that "border regions are mostly located in the periphery of the countries" (Erkut & Özgen, 2003). This situation, when the bordering region is peripheral at the same time, is related to the fact that earlier when determining the location of many economic entities, preferences were given to the central parts of the regions. Now, in order to change this situation, measures are actively taken to develop border areas, eliminate barriers between territories, and develop interregional cooperation (Gualini, 2003; Perkmann, 2003; Decoville et al., 2013; Chilla et al., 2012). The efficiency of such measures can be improved as a result of preliminary and subsequent evaluation of the impact of the location in regard to the interregional border on the variation of certain indicators of the MU.

This study tested the possibility to make such evaluation by using hierarchical analysis methods. The calculations made it possible to define differences between the MU located in the central part and along the border of the region. To a certain extent, it is possible to state that they helped to determine the importance of being located in the central part of the Russian subject and the impact it has (negative or positive) on the indicators of the socio-economic development achieved by the MU. However, it is necessary to treat these conclusions with caution, because only three indicators for one year had been considered, and one of them showed rather low results of evaluating the quality of calculations. The validity of the results would be more reliable if a larger number of indicators were covered and their changes were considered over time.

It is necessary to interpret the results of modeling with caution if it is determined that they are not important. Thus, the calculations on one of the considered methods of hierarchical analysis showed that according to the indicator "Social payments and taxable money incomes of the population" the location along the interregional border determines 7.4 % of the indicator variation, while according to the indicator "Investment in fixed capital" – only 3.4 %. The analysis made by using another method allowed defining the negative nature of the impact of the location on the achieved values of the indicator

"Social payments and taxable money incomes of the population". It was impossible to define such effect according to the indicator "Investments in fixed assets", because when modeling, it was not possible to obtain statistically significant results of the impact. Is this an indirect evidence of the fact that the interregional border and belonging of the MU to various Russian subjects are not important? This conclusion is supported by the fact that, in recent years, in order to level the socio-economic development, the tendencies of selective investment in depressed areas and municipal areas located on the interregional border have been highlighted in the policy of supporting investment activity. Such work is carried out in all regions of the country. As a whole, this could have an impact on the revealed inessentiality of the location along the interregional border and belonging to certain Russian subjects.

It is also necessary to note that one of the methods of hierarchical analysis provided grouping by the location in regard to the borders of the Russian subject as a separate level. This is an artificial formation of groups based only on the territorial location of the MU that are under the overall control of the Russian subject, and a necessary step in the hierarchical analysis. This must also be taken into account when making conclusions. At the same time, the territory of the Russian subject located at the border is not always a periphery. Accordingly, in further studies, it is possible to regroup the MU based on evaluating their socio-economic status in order to single out the core and its neighbors of the first, second and third order. This will allow assessing the importance of the territory location in regard to the core, but not to the borders of the Russian subject.

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## 6. Conclusion

As a result of the study, it has been determined that the methods of analyzing the regional

development can be extended by using the tools previously applied in other scientific areas. In the study the MU located on adjacent territories and hierarchically subordinating to the subjects of the Russian Federation can be considered in terms of their intergroup and intragroup variations. Based on the variation values, the intergroup and intragroup dispersion, interclass correlation coefficient and other indicators obtained during the calculations, the following conclusions have been made for seven analyzed subjects of the Russian Federation:

- The socio-economic status of the MU depends on its location in regard to the borders of the Russian subject and its hierarchical subordination. The MU located on the border of Russian subjects lag behind by the achieved values as compared to the MU located in the center,
- The location and hierarchical subordination of the MU is the most important for the indicator "Social payments and taxable money income of the population on average per one resident of the MU",
- The location and hierarchical subordination of the MU are of the least importance for the indicator "Investments in fixed assets (excluding budgetary funds) per one person", which is largely defined by the selective investments in developing the territories outlying from the center that is observed in many regions of the Russian Federation, and
- Due to including the categorical variable "cross-border", which is responsible for belonging of the MU to the territory containing the interregional border, the negative impact of the location along the borders on the considered indicators of the socio-economic development of the MU was determined.

The possibility of using the methods of hierarchical analysis, including multilevel regression modeling, to study the development of adjacent territories remains controversial. However, their use will allow taking management decisions on the basis of quantitative evaluations of the importance of the location of the unit under study in regard to the borders of the territory and its hierarchical subordination. In its turn, this will allow a reasonable approach to forming interregional relations at the level of the MU located in adjacent territories.

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## Bibliographic references

- Borraz, F., Cavallo, A., Rigobon, R., & Zipitria, L. (2015). Distance and Political Boundaries: Estimating Border Effects under Inequality Constraints. *International Journal of Finance & Economics*, 21(1), 3–35. doi:10.1002/ijfe.1517
- Chilla, T., Evrard, E., Schulz, C. (2012). On the Territoriality of Cross-Border Cooperation: "Institutional Mapping" in a Multi-Level Context. *European Planning Studies*, 20(6), 961-980. doi: 10.1080/09654313.2012.673563.
- Decoville, A., Durand, F., Sohn, C., Walther, O. (2013). Comparing Cross-border Metropolitan Integration in Europe: Towards a Functional Typology. *Journal of Borderlands Studies*, 28(2), 221-237. doi: 10.1080/08865655.2013.854654.
- Dube A., Lester T. W., Reich M. (2010). Minimum Wage Effects Across State Borders: Estimates Using Contiguous Counties. *IRLE Working Paper* No. 157-07. Retrieved from <http://irle.berkeley.edu/workingpapers/157-07.pdf>
- Engel C, Rogers JH. (1996). How wide is the border? *American Economic Review*, 86(5), 1112–1125.
- Erkut G., Özgen C. (2003) The Economic and Spatial Peripherality of Border Regions in Southeastern Europe. The 43rd European Congress of the Regional Science Association Jyväskylä, Finland 27th-30th August 2003 – 28p.
- Fomin V.M. (Editor-in-Chief) (2010). Prigranichnyye i transgranichnyye territorii aziatskoy

- Rossii i sopredelnykh stran (Border and transboundary territories of the Asian Russia and neighboring countries). Novosibirsk, SO RAS.
- Garson, D. (2013). Hierarchical linear modeling: guide and applications. Los Angeles, Sage Publications. doi:10.4135/9781483384450.
- Goldstein, H. (2010). Multilevel Statistical Models: 4th Edition. Wiley.
- Gualini, E. (2003). Cross-border Governance: Inventing Regions in a Trans-national Multi-level Polity, *disP. The Planning Review*, 39(152), 43-52. doi: 10.1080/02513625.2003.10556833.
- Huta V. (2014). When to use hierarchical linear modeling. *The quantitative methods for psychology*, 10 (1), 13-28. doi: 10.20982/tqmp.10.1.p013
- Khalikova, A.A., Lackman, I.A. (2015). Multilevel modeling of Ufa's labor demand. *Mathematical Modeling in Economics, Insurance and Risk Management: materials of the IV International Youth Scientific and Practical Conference*, 267—272.
- Lukin E.V., Uskova T.V. (2016). Mezhhregionalnoye ekonomicheskoye sotrudnichestvo: sostoyaniye, problemy, perspektivy: monografiya (Interregional economic cooperation: state, problems, prospects: monograph). Vologda, ISERT RAS.
- Moellering H., Tobler W. (1972). Geographical Variances. *Geographical Analysis*, 4, 35-50.
- Nitsch, V. (2003). Border Effects and Border Regions: Lessons from the German Unification. HWWA Discussion Paper No. 2036 25. *SSRN Electronic Journal*. doi:10.2139/ssrn.348642
- Pan J. (2014) The Role of Local Government in Shaping and Influencing International Policy Frameworks: a thesis submitted in partial fulfilment of the requirements of De Montfort University for the degree of Doctor of Philosophy. 2014. April. - 2014 De Montfort University Department of Politics and Public Policy
- Perkmann, M. (2003). Cross-Border Regions in Europe: Significance and Drivers of Regional Cross-Border Co-Operation. *European Urban and Regional Studies*, 10 (2), 153-171. doi: 10.1177/0969776403010002004.
- Raudenbush S.W. (1993). Hierarchical linear models and experimental design. *Applied analysis of variance in behavioral science* (Lynne K. Edwards Ed.). New York: Marcel Dekker.
- Requena, F., & Llano, C. (2010). The border effects in Spain: an industry-level analysis. *Empirica*, 37(4), 455–476. doi:10.1007/s10663-010-9123-6
- Reyting sotsialno-ekonomicheskogo polozheniya subyektov RF po itogam 2017 goda (Rating of the socio-economic status of the subjects of the Russian Federation in 2017). Ratings and Research | RIA Rating. (Electronic resource). Retrieved from <http://riarating.ru/infografika/20150616/610658857.html>
- Sinelnikov-Murylev, S. (2017). Russian economy in 2016. Trends and outlooks. Moscow, Foundation Gaidar Institute for Economic Policy, 520.
- Srholec, M. (2010). A multilevel approach to geography of innovation. *Regional studies*, 44 (9), 1207-1220. doi: 10.1080/00343400903365094.
- Yannis, G., Papadimitriou, E., Antoniou, C. (2007). Multilevel modelling for the regional effect of enforcement on road accidents. *Accident analysis and prevention*, 39, 818-825. doi: 10.1016/j.aap.2006.12.004.
- Yusupov, K.N., Timiryanova, V.M., Toktamysheva, Yu.S., Popov, D.V. (2018) Hierarchical and spatial effects in the development of municipalities. *Economic and Social Changes: Facts, Trends, Forecast*, 11(5), 137-154. doi: 10.15838/esc.2018.5.59.9

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