The population of the European North: concentration in the capitals of the regions

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Abstract. Four Arctic regions of the European part of Russia are considered in the article - Murmansk and Arkhangelsk regions, the republics of Karelia and Komi. The paper takes the example of these regionsto consider the spatial development of regions that have actively utilized the new opportunities generated by reforms. The effect of the market reforms initiated in Russia on the spatial development of the northern regions is show. Russian northern regions are going through noticeable spatial transformations, which are revealed by the analysis of the population dynamics of the municipalities of these four regions. It is noted that the development of municipalities is determined by their distance from the capital of the region, the farther from the capital, the faster the population of the municipality decreases. The region’s capital city is developing successfully, taking in resources from the periphery, and is gradually expanding spatially, engulfing and already exerting a positive effect on nearby municipalities, while resources are drawn to them and to the capital city from more remote municipalities. As cross-border cooperation is invigorated, it is borderland municipalities with the necessary customs and transport infrastructure that turn into active zones instead of most industrial municipalities.

1. Introduction
The development of regions is contingent on their geographic position, and peripheral northern regions usually develop at a slower pace than the rest, gaining additional opportunities only where active cooperation with adjacent regions of the other country is possible. To them, activation of the export of raw materials is essential, as it can render an impetus to their own development and bridge the developmental gap between them and central regions [1], [2], [3].

Globalization relieves some of the existing constraints on trade, which is beneficial for northern regions with rich natural resources. Liberalization of foreign economic activities has provided Russian northern regions with new opportunities, and some regions have managed to utilize them to mitigate the economic decline of the 1990’s [4], [5].

The reforms of the 1990’s have had a profound effect on the spatial development of regions, having intensified agglomeration processes [6], [7]. As economic growth recommenced, the spatial concentration of economic activities increased and peripheral regions have been developing far more slowly than the central ones [8], [9], [10]. Estimates based on data from the Russian Federation have demonstrated the significance of constraints for the development of peripheral regions, centripetal forces prevailed over centrifugal ones, the effect from involvement in international economic integration was minor and waning further [11].
Studies of spatial processes in regions have also revealed ongoing processes of concentration, and changes in the population size in municipalities were near linear, relative to the distance to the region’s capital city. Changes in the concentration depend on the local market capacity and the activity of interactions between agents [7], [10]. The development of peripheral regions is significantly influenced by the accessibility of foreign markets [4], [5], [12].

Within the “New economic geography” (NEG), spatial development is regarded as a result of a combined effect of centrifugal and centripetal forces, leading to the establishment of regional centers, forming a network of urban settlements. Each core is surrounded by a ‘hinterlands’, falling under its direct influence. The system of such cores remains relatively stable over time [13]. At the industrial and post-industrial development stages, such urban cores cast so-called ‘agglomeration shadows’. The city ‘soaks in’ the resources from nearby territories, thus slowing down their own development. As a result, successful urban settlements – agglomerations – become surrounded by zones in the agglomeration shadow, i.e. suffering a lack of resources caused by their vicinity to the city [14]. These hypotheses have been corroborated by a number of studies [15], [16], [17], [18]. They were found to work for Nordic countries, too [19], [20].

Spatial development models are being continuously upgraded, and new approaches are put forward [13], [19], [20]. Northern regions have some distinctive features, so various models were screened to choose the ones most suitable for them [7], [21]. To assess the effect of the regions’ position at the northern on their spatial development, the paper employs the concept of core-and-rings structures, comprising the core and the orbital active zones, which have a more up-to-date structure of the economy, higher labor productivity, and higher investment activity [22]. They possess an advanced innovation infrastructure, educational institutions, and a relatively high management level, permitting them to develop rapidly and attract resources from neighboring areas (passive zones). As a result, new enterprises emerge in active zones, and simultaneously old enterprises with obsolete processes are either shut down or relocated to passive zone, where taxes and production costs, particularly labor costs, are lower. As active zones develop, they spread out, the structure of their economy changes, the shares of education, culture, services, ICT and hi-tech industries increase.

Within the core-and-rings structures concept, the list of possible active zones for northern regions included, in addition to the region’s capital city, three more types – industrial hub, transport hub, and cross-border cooperation hub (borderland municipalities with multilateral motor vehicle border checkpoints and other requisite infrastructure) [23].

2. Methods
This paper analyzes the dynamics of the spatial development of four Arctic regions of the European part of Russia - the Murmansk and Arkhangelsk regions, the Republic of Karelia and Komi in the 1990’s – 2010’s, taking into consideration the effect of Russian reforms. Separate analyses of the development of the municipalities of four regions was carried out, active and passive zones were outlined, tendencies in the change of indices were investigated. The study was based on the population size dynamics, as well as used data on the gross regional product (GRP), employment, and production indices suggestive of the efficiency of the economy.

The statistical data obtained for four Arctic regions were processed to build and analyze the graphs of population size and other indices; changes in population size, employment levels and other parameters were compared for border and internal areas. It was analyzed how the efficiency of the economy influenced the population size, is there a dependence of the dynamics of the population on labor productivity in industry.

Areas with a developing economy and, as a rule, growing population – the core in the capital city and orbital zones – were identified through the analysis. Regression equations were then constructed to reveal correlations between spatial developments in four regions. Population growth since the baseline at the beginning of the period was considered in relation to the distance from the core active zone (Murmansk, Arhangel’sk, Syktyvkar, Petrozavodsk), and dummy variables indicating whether the area is an orbital active zone or whether it borders an orbital active zone were introduced as
additional factors. In addition to the linear function, the hyperbola and the multiplicative function with a negative exponent were used:

\[ N_i = A + B \times R_i + C_j \times p_i + D_j \times q_i, \]  
\[ N_i = A + \frac{B}{R_i} + C_j \times p_i + D_j \times q_i, \]  
\[ N_i = A \times R_i^\alpha \exp(C_j \times p_i + D_j \times q_i) \]  
\[ N_i = A + B \times RL_i \] (1-4)

where: \( N_i \) is the change in population size in the municipality \( i \); \( R_i \) is the distance to the core active zone; \( RL_i \) is the distance to the nearest active zone; \( p_i=1 \) if the municipality \( i \) is the active zone \( j \), otherwise \( p_i=0 \); \( q_i=1 \) if the municipality \( i \) borders the active zone \( j \), otherwise \( q_i=0 \); \( A, B, C, D, \alpha \) are constants. Calculations were also performed without dummy variables, and the focus in that case was on the distance to the nearest active zone [23].

The period 1989-2018 was considered. The results obtained were analyzed in the course of the calculations and the model was fitted, permitting the effect of active zones on passive zones to be assessed, the conditions for a positive or a negative effect to be revealed, and the factors influencing the development of passive zones to be identified.

The rationale for choosing population size and employment for the calculations was that these indices can produce relatively long time series independent of price volatility, change of national currencies, or inflation. Besides, generalized municipality-level production statistics is missing for Russian regions, with only sectoral indices available (industrial production, agricultural production), while structurally, the economies of municipalities vary strongly across the regions, and it is hard to compare them.

3. Data
Data for the study for four Arctic regions (population size, GRP, turnover of businesses, number of employed persons) were taken from reference books published by the Federal State Statistics Service [24], and from her websites (http://www.gks.ru). The accuracy of the dynamic series on population size is ensured by censuses, current data from yearbooks were checked against the results of the 2002 and 2010 censuses. The population of four regions and nearly all of its municipalities has been declining since 1990; economic growth commenced in 1999, after the crisis of 2008-2009, this growth has resumed (Figure 1).

![Figure 1. Population dynamics of four regions of the European North (thousand people)](image-url)
The population of the Murmansk region has declined since 1990 by 36%, the Komi Republic - by 33%, the Arkhangelsk region - by 27% and Karelia - by 22%.

4. Result and Discussion
For four Arctic regions in general, the overturn of former tendencies was associated with the beginning of market reforms, and since around 1990 there began an economic decline and a reduction in population size. In the 1970’s and 1980’s, the economy of four Arctic regions was developing successfully, industrial hubs were growing, and so was the population. The government was investing in industrial enterprises, the growing industry required new employees, and hence there was demand for more population. Towns were growing and new industrial enterprises were built. Before the market reforms began, the role of active zones in the northern regions had belonged to industrial hubs.

In the 1990’s, an industrial decline began, enterprises stopped operating, northern areas started losing population. In all four regions, the minimum economic downturn was in the municipalities where raw materials demanded in other countries were extracted and processed. In the northern peripheral regions, the population was rapidly declining, but the population of the capitals of the regions almost did not change during the years of reform.

Owing to liberalization of border procedures and lowering of border barriers, Karelian economy started gaining benefits from its position at the border, the role of border municipalities equipped with the necessary transport and customs infrastructure was growing. In the 1990’s, the population decline has been minimal also in the two border towns (Kostomuksha and Sortavala) close to which multilateral border checkpoints for motor vehicles were built. Branches of the Petrozavodsk University were established in Sortavala and Kostomuksha, and small business was developing in the towns. At the same time, position at the border had no effect whatsoever on the population size in the rest five of border municipalities, where the necessary infrastructure was missing.

The 2000’s saw some expansion of the core active zone; population loss slowed down markedly around Petrozavodsk, but gained momentum in hinterland municipalities. A majority of municipalities at that time starting losing population at a higher rate than in the 1990’s.

To plot the graphs and analyze them, data on employment and population size changes in 18 Karelian municipalities, as well as distances between municipality centers along existing roads were considered. For each municipality, the distance to Petrozavodsk, Sortavala and Kostomuksha was determined, as well as whether they bordered the Sortavala and Kostomuksha municipalities.

Analysis of the graphs revealed a correlation between changes in the municipality population size and the distance to the core active zone – the scope of change in population size over the 1990-2018 period depended on this distance (Figure 2).

![Figure 2. Dependence of changes in population size (% of 1989 level) on distance to the region’s capital city (km)](image-url)
Based on the results of this analysis, a linear equation was constructed, showing that on average every 33 km of increasing distance from Petrozavodsk added 1 percent point to the amount of population loss over the 1991-2018 period. Petrozavodsk has a positive effect on its neighboring municipalities. The effect of borderland active zones proved to be negligible, positive for some neighbors and negative for others. Calculations by equation (4), where the distance to the nearest active zone is considered, had somewhat poorer statistical characteristics (table 1).

Table 1. Results of calculations by formulas (1), (2), (4) for the dependence of changes in population size in 1989-2018 on the distance to the active zone and adjacency to them

|                  | (1)       | (2)       | (4)       |
|------------------|-----------|-----------|-----------|
| A                | 69.5 ***  | 55.53 *** | 90.7 ***  |
| B                | -0.0317 *** | 0.712 *** | -0.194 *** |
| Kostomuksha      | 40.1 ***  | 36.23 *** |           |
| Sortavala        | 19.5 ***  | 22.68 *** |           |
| Petrozavodsk neighbors | 18.6 *** | -38.86 *** |           |
| R²               | 0.87      | 0.81      | 0.74      |
| F                | 19.6      | 12.9      | 31.1      |
| p                | 0.00003   | 0.0002    | 0.0002    |

*** p<0.01

A similar, but slightly different situation is pictured by the graph for employment dynamics. Employed people tend to migrate to the active zone proportionately to the distance to it as long as this distance is within 170 km, after which, up to the distance of 300 km, the outflow of employed persons wanes, to rise again farther away.

Analysis of the municipalities has demonstrated that such population relocations are only partially explained by the performance of the municipality’s economy, as estimated by labor productivity in the industry. There is outmigration of population from less efficient to more efficient municipalities, but some of the most efficient municipalities have experienced an outflow of population towards ones that were less efficient, but had a more progressive structure of the economy.

The analysis of the population dynamics of the remaining three regions confirmed the conclusions made for Karelia. In each of the regions, the dependence of the dynamics of the population on the distance to the regional capital has formed. Several municipalities are more successfully developing from the general dependence. In the Arkhangelsk region, it is Koryazhma, a paper production center and Kotlas, a transport center on the border of three regions. In the Komi Republic, these are four municipalities in which oil is produced. In the Murmansk region, this is the Polar Dawns, where the nuclear power plant is located. Table 2 shows the results of calculations by the formula (1). In the second column, normalized data were used for calculations, reduced by the size of the decrease in the region’s population.

Table 2. The results of calculations by formula (1) depending on the dynamics of the population in 1989-2018 from the distance to the region’s capital for the four northern regions

|                  | Non-normalized data | Normalized data |
|------------------|---------------------|-----------------|
| A                | 67.46 ***           | 96.73 ***       |
| B                | -0.0257 ***         | -0.0405 ***     |
| Mining and processing centers | 22.55 ***         | 35.95 ***       |
| Innovation and other centers | 20.01 ***           | 22.41 ***       |
| R²               | 0.58                | 0.60            |
5. Conclusion

Four Arctic regions were taken for the case study of the spatial development of Russian regions that have actively utilized the new opportunities generated by integration processes and Russian reforms. The effect of the initiation of market reforms in Russia on spatial development patterns was demonstrated; equations relating population size dynamics to the distance to the core active zone and adjacency to orbital active zones were constructed. It was noted also that the development of passive zones is contingent upon the distance to active zones.

Noticeable spatial changes have been happening inside northern regions. The spatial development patterns revealed by the analysis of Republic of Karelia municipalities were an expansion of the regional core active zone and transformation of the system of orbital active zones. The core active zone takes in resources from passive zones and sprawls out gradually, engulfing and influencing, now positively, the neighboring municipalities, while resources for the core and its neighbors are drawn from the municipalities farther away. As cross-border cooperation is invigorated, it is borderland municipalities with the necessary customs and transport infrastructure that turn into active zones instead of industrial municipalities. Successfully developing municipalities in which natural resources are extracted and processed.

The size of the active zones and the reach of their influence gradually increase, and they begin to take hold of resources from farther away. This is the most true for the regional core active zone.

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