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VANGUARD AND LAGGARD RURAL POPULATION CLUSTERS IN LATVIA

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Abstract. Previous studies have shown stark differences in terms of demographic development among rural municipalities of Latvia. Application of the non-hierarchical cluster analysis methodology allowed classifying distinct groups of municipalities based on their demographic potential and vulnerabilities. This study aims to provide an update to the demographic typology of rural municipalities and to discuss main differences between vanguard and laggard municipality groups, using latest statistical information and the available population survey data. Study employs established four-cluster model for the rural municipality typology and relies on latest official statistics, as well as the data obtained during 2021 "DemoMig" population survey. Study results confirm the validity and utility of the four-cluster model, highlighting extreme disparity in population dynamics between the municipalities assigned to "Population growth" and "Accelerated depopulation" groups. Understanding the differences between the two moderate groups of municipalities – "Balanced population change" and "Moderate depopulation" is found to be highly important from academic and policy perspective. Thorough review of the municipalities included in specific clusters sheds some light on the internal regional processes and factors shaping their demographic situation. Study demonstrates that these factors often go beyond mere differences in spatial location. Different groups show some surprising similarities in their core demographic indicators, which provide grounds for cautious speculations on possible long-term recovery scenarios. Analysis of the survey responses of local residents gives hints for implementing some corrective policy measures.

Key words: regional demography, cluster analysis, population survey data.
JEL code: J11, I38, R11

Introduction (data and methods)

Many studies (Krisjane et al., 2017; Berzins et al., 2018; Baranauskiene and Burneika, 2021) have confirmed differences in demographic situation and changes between rural municipalities of Latvia and other two Baltic States. Available data and previous research results (CSB, 2023; Berzins and Zvidrins, 2001; Pluschke-Altof et al., 2020) identify a progressing core-periphery divide among rural municipalities in Latvia and its neighbouring countries. That is highlighting a need to elaborate a robust evaluation and monitoring framework in order to properly evaluate and address this issue (Apsite-Berina et al., 2020; Brzozowska et al., 2023). Close connection between the socio economic determinants and general demographic indicators are well established (Zarins and Paiders, 2020; Berzins et al., 2018). However, when looking at individual municipalities, one may notice distinct variations and unexpected outliers requiring closer examination. Application of the non-hierarchical cluster analysis methodology allows quickly and effectively to classify, to evaluate and monitor distinct groups of municipalities based on their demographic characteristics, while highlighting nuanced demographic topography and indicating outlier cases for further review.

The aim of this study is to provide an update to the demographic typology of rural municipalities and to discuss differences between vanguard and laggard municipality groups by using the latest statistical information and survey data.

Since 2020, the number of rural population in Latvia has remained rather stable, forming approximately 0.6 million residents. At the beginning of 2023, the share of rural area residents in the total population was 30.2 % (CSB, 2023) residing in all 36 municipalities (novadi) of Latvia. Seven cities, which form urban municipalities, are not forming the object of this research. Among 36 municipalities, included in the

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analysis, there is only one – Jelgava municipality without any towns, 15 are with single town, 11 with two towns and 9 with 3 to 4 towns. Therefore, the terms used in this paper – "rural population clusters" and "rural population municipalities" are conditional, because all municipalities (excluding Jelgava municipality) still have some proportion of urban population (usually less than 50%).

From the methodology perspective, this study employs a slightly revised version of the previously established four-cluster model (Krisjane et al., 2021) for the rural municipality typology. Use of different cluster analysis models for categorisation of territorial units of Latvia has been successfully tested in the past and demonstrated valuable results (Melluma et al., 1996; Brauksa, 2013). Clustering approach used in this study relies on the unsupervised non-hierarchical clustering - a well-proven K-medoids PAM (Partitioning around Medoids) algorithm (Kaufman and Rousseeuw, 2009). This approach is considered a good option to achieve the aim of this study, because it allows greater freedom in choice of selected parameters, particularly when compared to a classical regression tools. The main benefit of this methodology is underlined by the fact that the clusters are assigned by an impartial machine-learning algorithm. Unlike more traditional hierarchical clustering methods, it is independent of any subjective measures or expectations of similarity between observations (Peters, 1958), which is a very important aspect for this study.

The data used in this study were obtained from the national statistical database (Official Statistics Portal, 2024). A four-year period from 2018 to 2021 is used for capturing the dynamic elements of the cluster model. The data published in 2022 are not used in this study to avoid irregularities introduced by the settlement of refugees from Ukraine. The fixed data observations are provided for 01.01.2021 - the latest nationwide Population census. The study also relies on the findings of the population survey (n=4457) carried out in 2021 throughout the country within the framework of the research project "DemoMig".

The study results confirm validity and utility of the four-cluster model, highlighting disparity in population dynamics between the municipalities assigned to "growth areas" and "depopulation crisis areas" groups. Understanding the differences between the two moderate groups of municipalities – "stagnating areas" and "areas of emigration" is found to be highly important from academic and policy perspective. The analysis of the municipalities located on the fringes of these clusters helps uncovering and explaining the processes driving the transition of municipalities between clusters.

Thorough review of the municipalities included in specific clusters sheds some light on the internal regional processes and factors shaping their demographic situation. The study demonstrates that these factors often go beyond mere differences in spatial location. Different groups show some surprising similarities in their core demographic indicators, which provide grounds for cautious speculations on possible long-term recovery scenarios. The analysis of the survey responses of local residents gives hints for implementing corrective policy measures.

Research results and discussion

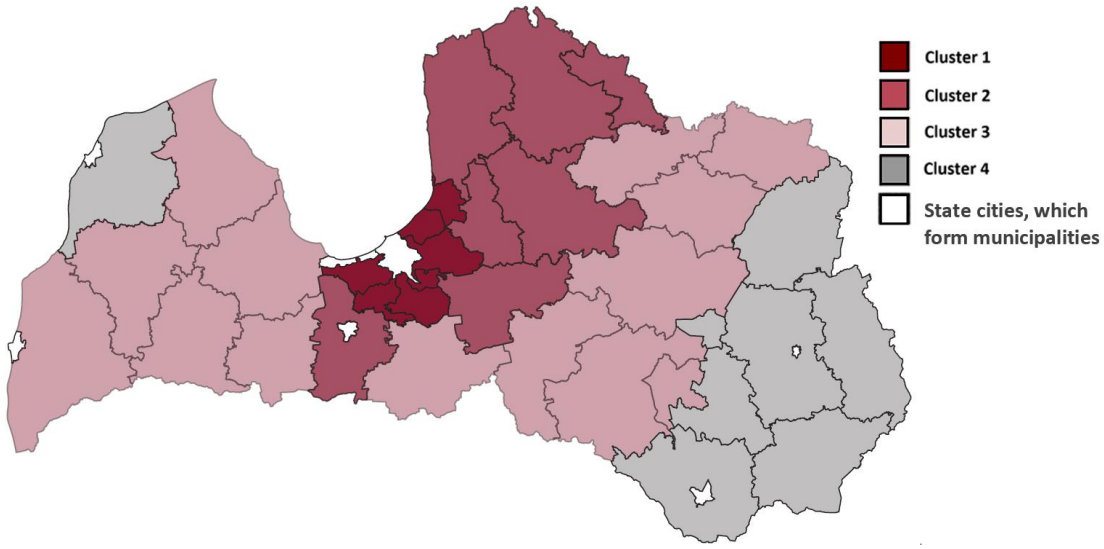
This research is structured in tree sections identifying, explaining and discussing disparities of population development among rural municipalities. The first sub-section provides the results and review of the most recent cluster analysis utilising the four-cluster model produced by non-hierarchical clustering algorithm. The second section compares municipalities included in each cluster and addresses observed disparities between the identified groups. The third section utilises the results of the population survey data among residents of the municipalities falling under each identified cluster and provides discussion on possible corrective measures.

1. Defining clusters

According to the study's aim and methodology established in the introduction, the authors begin by conducting a cluster analysis of the rural municipalities (novads) of Latvia using PAM clustering methodology. In order to ensure relevance of the study, the authors use the municipal structure of Latvia established after the 2021 Administrative-territorial reform. Urban municipalities designated as State cities are omitted form the cluster analysis in order to avoid outliers and other data issues.

In order to ensure continuity with previous research, a previously established and tested four-cluster model is used in a slightly modified form. The four-cluster model is adjusted to include new parameters better capturing the local demographic situation and processes. The model parameters include population density in 2021 (residents per square kilometre), natural population growth (%) and net migration (%) between 2018 and 2021, as well as demographic load in 2021, and number of children (0-14) per 100 senior (64+) residents in 2021. Taking into account the recent findings on the importance of gender ratio in the local demographic processes (Dahs et al., 2023), another statistical parameter – Percentage of male population in working age (15-63) is also added to the model.

Figure 1 shows the clustering results on the map of Latvia.



Source: author's calculations based on Official Statistics Portal of Latvia, 2024

Fig. 1. **Results of the unsupervised clustering of Latvian municipalities based on selected demographic indicators, 2018-2021**

In order to better explore and describe the obtained cluster assignments, it is useful to look at the individual municipalities representing each group. Table 1 provides information on the demographic indicators of the municipalities identified at the centre of each respective cluster.

Table 1

Demographic characteristics of rural municipalities in Latvia representing four clusters in accordance to the chosen data set, 2018-2021

Cluster	Municipality	Population density (residents per sq km, 2021)	Natural population growth (2018-2021)	Migration saldo (2018-2021)	Percentage of males in 15-63 age group (2021)	Number of children (0-14) per 100 senior (64+) residents in 2021	Demographic load in 2021
1	Ādaži municipality	93.94	0.53	10.36	50.05	130.37	60.67
2	Ogre municipality	32.61	-1.55	1.17	49.54	86.21	63.65
3	Talsi municipality	13.35	-2.75	-2.81	51.32	65.66	61.23
4	Balvi municipality	8.13	-5.39	-3.70	52.27	56.13	57.15

Source: author's calculations based on Official Statistics Portal of Latvia, 2024

Based on the information provided above, it is now possible to describe each of the identified municipality types.

1) Population growth areas – municipalities located within the metropolitan area of Riga city, showing high population density, favourable age structure, positive population growth and average demographic load. These municipalities also show a stable proportion of working age females in their population composition.
2) Balanced population change areas – municipalities with average population density, slightly negative natural population change and stable or positive migration balance. These municipalities usually have the highest demographic load numbers, somewhat unstable population age structure with almost equal numbers of minor and senior residents. These areas demonstrate gender distribution with higher share of females within working age cohort.
3) Moderate depopulation areas – municipalities with sub-average population density, relatively high demographic load and high rates of out-migration. These areas also demonstrate unstable population structures, stagnant or negative natural population change and above-average predominance of working age males.
4) Accelerated depopulation areas – municipalities with especially low population density, very low share of young residents and extremely high levels of depopulation due to negative natural movement and negative net migration. These municipalities also demonstrate the highest population share within the working age group and biggest male-to-female gender disparity within working age population.

One can immediately notice a presence of a strong core-periphery dichotomy among the identified clusters (Lang et al., 2015). Clustering results highlight significant disparity in population dynamics between the municipalities assigned to "Population growth areas" located around Riga city and "Accelerated depopulation areas" situated primarily within the Latgale region. Differences between the two moderate groups of municipalities – "Balanced population change areas" and "Moderate depopulation areas" are less extreme and more nuanced. Further analysis of these two clusters may prove valuable from both academic and policy perspective.

Cluster analysis results also confirm presence of a strong link between gender balance among working age population and local population dynamics. This parameter should be considered in future research and modelling efforts in this field of study.

Based on these observations one can make provisional conclusions about the growing influence of Riga city and its metropolitan area on the demographic landscape throughout the country. The spill-over effects of the Riga metropolitan area are also evident among municipalities assigned to the second cluster, where stable population numbers are linked mainly to the neutral or positive net-migration driven by extended sub-urbanisation processes and easier access to the social and economic infrastructure of Riga. State cities located outside of the extended Riga metropolitan area show no positive effects on their surrounding rural areas. Specific cases and variations of these trends will be addresses in the next section of this study.

2. Understanding disparities

In this section, the authors review municipalities included in each cluster and address disparities between the identified groups. Particular attention is devoted to clusters two and three, as well as municipalities located on the statistical fringes of these clusters.

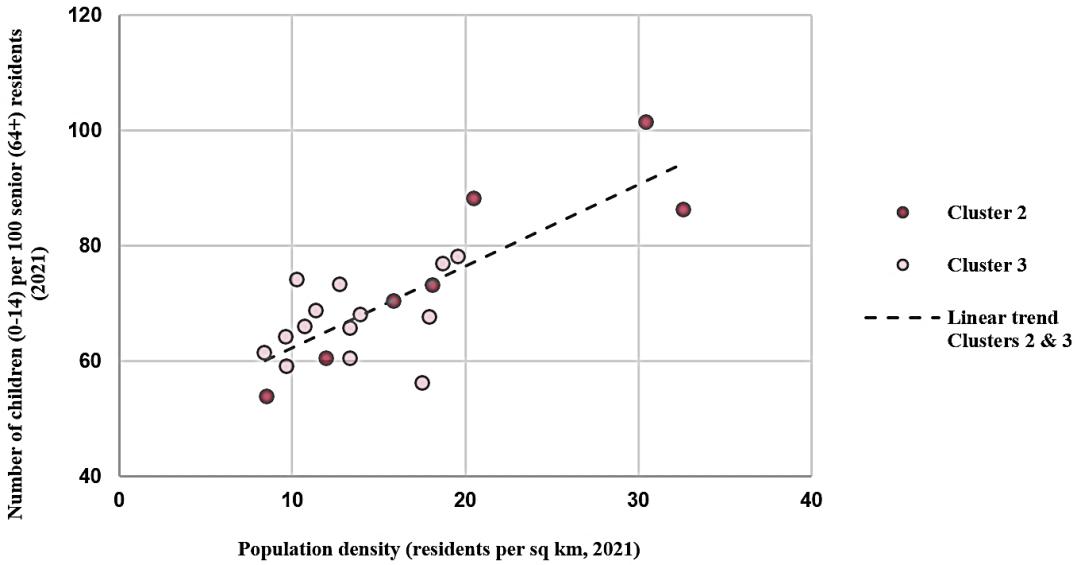
The first cluster consists mainly of the municipalities of the Riga planning region. The nearby Saulkrasti municipality (Vidzeme planning region) is added to them. In four of the seven municipalities of this cluster,

the natural population change is positive. Therefore, the number of children also exceeds the number of seniors. Like in the city of Riga, the number of women in this cluster exceeds the number of men at working age. The migration rate is especially high in this cluster, which indicates the move of young families to the urban area of Riga. However, it should be considered that in the period under review, legislative changes have taken place in several municipalities, which provide for increased real estate tax for dwellings in which no person has been declared. Therefore, in municipalities with a large proportion of summerhouses (mainly in coastal areas - in the Saulkrasti and Ādazi municipalities), sometimes the increase in the number of residents also occurs when someone from the family declares in a summerhouse. However, even without this reason, the net migration in these municipalities would probably be positive.

The second cluster consists of seven municipalities, and the third - 14. Geographically, the second cluster mainly includes municipalities located in the North-West part of the Vidzeme planning region. The nearby Sigulda municipality (Riga planning region) and Jelgava municipality (Zemgale planning region) have been added to them. The third cluster is geographically broader – it includes the municipalities of all the planning regions except Riga. However, in terms of demographic indicators, the municipalities united in the third cluster are more similar to each other than those ones united in the second cluster - the amplitude of all indicators is smaller. This allows to judge the third cluster as a group with a similar demographic situation and to assume that the problems and solutions in these municipalities could also be similar.

Analysing the differences between the second and third clusters, the reviewed indicators are related to each other. Briefly, this difference could be described as the level of aging of the area as a direct product of population composition and level of public and private investment (Grube and Paiders, 2020; Ubareviciene et al., 2016). The number of children per 100 seniors in the second cluster is below 70 only in two municipalities, while in the third cluster such situation is typical in most of the municipalities. Aging is also evidenced by the natural population change, which is more negative in the third cluster than in the second one. The third cluster also has a lower population density. This is a very worrying factor, considering the latest state policy in the optimization of the school network, where schools and kindergartens are closed in municipalities with low population density. This could contribute to the emigration of families with children from the municipalities of the third cluster, thus affecting the age structure and further strengthening the differences with the second cluster.

The chart in Figure 2 shows the relationship between two indicators – "population density" and "number of children per 100 seniors" in municipalities of the second and third clusters. The clearly visible, linear relationship shows that families with children prefer to choose more densely populated areas, while seniors continue to live in areas that are gradually emptying out. The unbalanced age structure causes multiple problems and requires tailored solutions (Schorn, 2023). The large proportion of single seniors in less populated areas creates additional tasks for municipalities in terms of social support. On the other hand, the support that seniors could provide in looking after their grandchildren is not possible because grandparents live far from their family.



Source: author's calculations based on Official Statistics Portal of Latvia, 2024

Fig. 2. **Correlation between population density and number of children (0-14) per 100 senior residents (64+) in clusters 2 and 3, 2021**

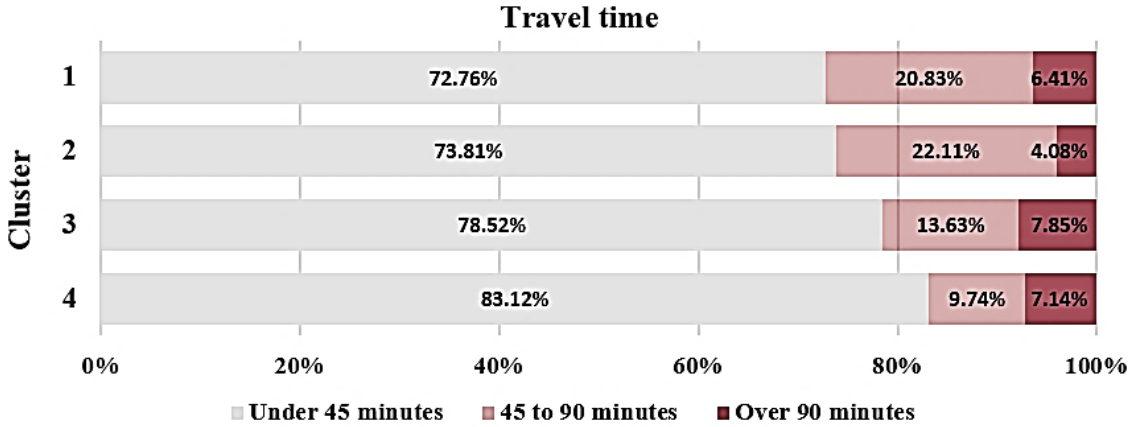
The fourth cluster includes mainly the municipalities of the Latgale planning region. The nearby Varaklani municipality (Vidzeme planning region) is added to them. This cluster also includes Ventspils municipality (Kurzeme planning region), which is geographically far from the other municipalities of the fourth cluster. The indicators of this region show the need to pay special attention to the demographic situation of Latgale region, which is in a state of depopulation crisis. It is possible that the studies carried out in the regional workshops of "DemoMig" project on the perspective of the inhabitants of Latgale on the reasons for migration and aging in the region would be useful for the further analysis of the situation.

Ventspils municipality is included in this cluster due to the low population density as well as the large proportion of men of working age. The other indicators for Ventspils municipality are closer to the third cluster. However, it is possible that cooperation and exchange of ideas between Ventspils municipality and Latgale municipalities regarding solutions in areas with low population density is possible, which would make a positive contribution to both Ventspils and Latgale. In addition, municipalities of cluster four demonstrate significantly lower demographic load highlighting the untapped economic and social development potential of these areas.

3. Development obstacles and future prospects

This section builds on the results of the population survey data carried out among residents of Latvia in 2021 (n=4457) within the framework of "DemoMig" project. By addressing the discrepancies in survey answers among residents of municipalities falling under different clusters, authors examine the subjective dimension of the observed demographic disparities and search for possible improvement scenarios.

Following the observations from the previous sections, the authors proceed to exploring the role of accessibility and transport infrastructure in the distribution of municipalities among various clusters. Figure 3 demonstrates the aggregated results of questionnaire responses regarding the average travel times to the place of work or study provided by survey respondents residing in each cluster municipalities.



Source: author's calculations based on 2021 "DemoMig" population survey

Fig. 3. **Average travel times to the place of work or study, as indicated by survey respondents residing in each cluster municipalities in 2021 (% of answers)**

Over 70% of responders in all four clusters have indicated that they spend less than 45 minutes for a one-way commute. Furthermore, the share of short commute times increases progressively with each cluster – up to 83% in the fourth cluster. Demographically stable first and second clusters show the highest proportion of population spending 45 to 90 minutes to reach their place of work or education (over 20% and 22% respectively). The highest share of long commute times over 90 minutes was indicated by residents of cluster three and four (over 7%).

These results indicate that daily commute times play an important role in shaping the demographic conditions in rural municipalities. Municipalities with better interconnection with Riga metropolitan areas (first and second clusters) show greater willingness of population to spend moderate time for the daily commute in exchange for access to opportunities provided by Riga metropolitan area. At the same time, residents of the more distant municipalities (clusters three and four) look for local work and education prospects as an alternative to enduring very long travel times. This observation for third and fourth cluster also highlights the lack of appropriate substitute employment and education places in the regional urban centres situated within the average travel time limits. Solutions to this issue include the promotion of remote work, improving the rapid transportation infrastructure and facilitating the development of substitute social and economic infrastructure in the regional development centres located within the average travel time (under 90 minutes).

Results of the survey questions regarding the migration plans have shown generally low mobility intentions across all clusters. Residents of municipalities in the first cluster have demonstrated the highest migration intentions (over 8% of respondents), preferring to change residence within the current municipality (3%) or move to a different municipality (3.2%). Residents of the second cluster show the lowest willingness to move (just over 5% or respondents) and prefer changing residence within the same municipality. Clusters three and four show high willingness of residents to move to a different municipality, while residents of cluster four also demonstrate the highest intentions to move abroad (3.6%). Table 2 provides breakdown of the survey results regarding migration intentions among residents of all four clusters.

Table 2

Migration intentions within the next year, as indicated by survey respondents residing in each cluster municipalities in 2021 (% of answers)

Cluster	Migration plans			
	No	*Within current municipality*	*To a different municipality*	*To a different country*
1	91.37%	2.96%	3.23%	2.43%
2	94.63%	2.80%	1.64%	0.93%
3	93.99%	1.84%	3.01%	1.17%
4	92.00%	1.20%	3.20%	3.60%

Source: author's calculations based on 2021 "DemoMig" population survey

It is possible to conclude, that survey responses for cluster one are generally in line with migratory behaviour of economically active and younger population (Skrbis et al., 2014). The responses from residents of cluster two confirm previous conclusion about these municipalities being attractive for immigration and long-term settlement, suggesting the presence of extended sub-urbanisation process in these municipalities driven by the expansion of Riga metropolitan area. Migratory intentions of residents in cluster three also confirm this cluster's classification and statistical observations on the accelerating out-migration of its economically active population to other regions within Latvia. Residents of cluster four show little interest in moving within the same municipality, accompanied by prevalent plans to migrate to a different municipality or abroad (Kozlovs, 2019).

These observations support conclusions about the role of extended sub-urbanisations effects presented by Riga city. State cities and urban centres geographically situated in clusters three and four show no such effects and in some cases (e.g. Ventspils municipality) drain economically active population form their surrounding rural areas. With this in mind, restarting and encouraging the sub-urbanisation processes of the population centres outside Riga metropolitan area is crucial for revitalisation of the surrounding rural areas (Camaioni, et al., 2019).

Table 3 provides the summary of survey responses regarding population opinion on necessary demographic policy measures. Although the general trend of responses is quite even throughout the rural municipalities of all four clusters, there are notable differences present in the support level for specific policy actions between the clusters. Support for measures aimed at increasing birth-rate is highest in cluster two (over 25%) and lowest in cluster four (below 17%). Cluster four residents also showed the highest interest in policies aimed at promoting healthy and active lifespan, reducing out-migration and supporting re-migration. Residents of the first cluster municipalities are more welcoming to the idea of limited immigration of foreign nationals (over 4%), while cluster four residents overwhelmingly reject this idea (below 1% support). Residents of the third cluster showed significantly high interest in policies reducing social inequalities (over 26%), while the first and second cluster respondents showed somewhat higher support for improvement of education and professional skills.

Table 3

Necessary demographic policy measures, as indicated by survey respondents residing in each cluster municipalities in 2021 (multiple-choice, % of answers)

Cluster	Policy measures						
	Measures aimed at increasing birthrate	*Improving health and active lifespan*	*Measures aimed at reducing out-migation*	*Measures supporting re-migration*	*Supporting limited immigration of foreign nationals*	*Reducing social inequalities*	*Supporting education and development of professional skills*
1	22.34%	19.93%	12.03%	8.59%	4.12%	19.24%	13.75%
2	25.59%	16.47%	11.47%	8.24%	1.47%	22.94%	13.82%
3	20.87%	16.97%	12.61%	8.72%	2.29%	26.15%	12.39%
4	16.67%	21.90%	17.14%	10.95%	0.95%	20.48%	11.90%

Note: Multiple-choice question – row totals may exceed 100%.
Source: author's calculations based on 2021 "DemoMig" population survey

These responses fall in line with previous observations and support conclusions about extended sub-urbanisation processes in cluster two, as well as growing social inequalities and increasing pressure to migrate within cluster three. Sub-urban areas located in cluster one show greater acceptance of foreign workforce, although the overall level of support for this policy remains very low. Policy options supported by residents of cluster four correspond with the priorities exhibited by ageing population; however, these options seem to be less realistic in the current situation and require cautious implementation (Kruzmetra et al., 2016). On the contrary, policies aimed at promoting birth-rate, immigration of foreign workforce and development of professional skills were least popular in cluster four. This underlines the urgent need for better communication strategy in support of the national regional development objectives (Saeima, 2010).

Conclusions, proposals, recommendations

1) Clustering results highlight a significant disparity in population dynamics between the municipalities assigned to four clusters: (1) "Population growth areas"; (2) "Balanced population change areas"; (3) "Moderate depopulation areas", and (4) "Accelerated depopulation areas".

2) The social and economic spill-over effects of the Riga metropolitan area are evident among municipalities assigned to the second cluster, where stable population numbers are supported mainly by the neutral or positive net-migration driven by extended sub-urbanisation processes of Riga metropolitan area.

3) State cities and urban centres geographically situated in clusters three and four show no positive sub-urbanisation effects. With this in mind, restarting and encouraging the sub-urbanisation processes of the population centres outside Riga metropolitan area are crucial for revitalisation of the rural areas in these territories.

4) The difference between the second and third cluster is mainly related to the population density and level of aging. Analysis results show that families with children choose more densely populated areas, while seniors continue to live in areas that are gradually emptying out.

5) Migratory intentions of residents in cluster three confirm observations on the accelerating out-migration of its economically active population to other regions within Latvia driven by growing local social inequalities.

6) Daily commute time plays an important role in shaping the demographic conditions in rural municipalities. The difficult demographic situation in clusters three and four is exacerbated by the diminishing accessibility of employment and education infrastructure located within reasonable travel time.

7) Corrective policy options supported by residents of cluster four correspond with the priorities exhibited by ageing population. Rejection of more urgent and effective policies within this cluster leads to conclusion about the urgent need for better communication strategy.

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