Role of public services in maintaining the population of settlements

Tamás Szabó
Engineer-economist
Email: tamas.szabo@hotmail.com

Regional competitiveness significantly influences the quality and accessibility of public service delivery. Research indicates that competition plays a pivotal role in shaping accessibility indicators, particularly spatial accessibility, which are critical for sectors such as transportation, urban planning and healthcare (Douthit et al. 2015, Guagliardo 2004, OECD 2021). The spatial distribution of public service facilities affects the quality of life of residents, and different degrees of agglomeration and accessibility are observed between different categories of facilities (McGrail et al. 2017). Moreover, the spatial impact of the availability of public services on house prices highlights the potential for greater clustering effects of public services (Diao et al. 2017). The availability of public service infrastructure also serves as an informative signal for citizens to assess political performance, influences political trust and potentially contributes to geographically polarised perceptions of quality (Christensen–Lægreid 2005). In this paper, the author undertakes a multivariate statistical analysis of the indicators mentioned above related to public services to investigate the impact of the qualitative characteristics of the indicators included in the analysis on the variation of population and demographic characteristics of municipalities. The results show strong positive correlations between the availability of educational, health and cultural public services and population retention. Areas with higher business incomes and well-developed public services tend to experience lower rates of out-migration. These findings underscore the importance of integrating economic and social development strategies to enhance rural demographic stability.

Keywords:
public services,
accessibility,
population change,
multivariate statistical methods

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Introduction

The population retention capacity of settlements is a crucial factor for sustainable development and the long-term stability of local communities. Population retention refers to a municipality's ability to maintain and expand its population by ensuring an adequate standard of living, ample employment opportunities and accessible public services. Preventing out-migration and retaining population is particularly important in rural areas where economic opportunities are often limited and infrastructure development is challenging (Reilly 2021). One way to improve population retention is to increase the quality and accessibility of public services. Public services, such as health care, education and transport, play a crucial role in ensuring the quality of life of the population and strengthening the local economy (Uzzoli et al. 2022, Kulcsár–Obádovics 2016). Local economic development and job creation are essential for increasing population retention. Expanding economic opportunities and supporting entrepreneurial activities can strengthen local communities and reduce out-migration to cities (Reilly 2021). Additionally, such developments have a positive impact on the demographic stability of local communities by making the area more attractive to younger generations, who are more likely to stay or move back to the area (Kulcsár–Obádovics 2016). Although both social and economic dimensions are relevant, this paper focuses on the economic aspects of public service provision due to the availability of quantifiable indicators and data reliability. Future research may address the social dimension through qualitative case studies or survey-based methods. Moreover, it must be emphasised that where economic potential is concentrated, both the population and the intensity of public service provision tend to increase. Thus, public service coverage at levels above NUTS 3 can serve as an indicator of the territorial competitiveness of specific regions.

Economic aspect

Economic factors play a crucial role in determining the accessibility of public services in rural areas. The level of economic development influences both the quality and availability of essential services, including healthcare, education and transportation. Stronger local economies can devote more resources to these services, while in less economically developed areas, these services are often underfunded and less accessible (Grodecka–Hull 2019). Research shows that the accessibility of public services in rural areas depends on several factors, including the state of infrastructure and the development of transport networks. Infrastructure development, such as improving road networks, can increase access to public services, reduce social inequalities and promote rural development (Higgs–White 1997).

Another critical factor in improving access to public services is the role of community resources, so-called endogenous resources. Informal support networks, such as assistance from neighbours and relatives, play an essential role in increasing

access to public services in rural areas. Community participation and voluntary activities can also help enhance the efficiency of public services (Vitale Brovarone–Cotella 2020). Overall, economic development and the effective use of community resources are essential to improve the accessibility of public services in rural areas.
Endogenous resources, such as the local economy and community resources, are key to sustainable development. In rural areas, local resources, such as agricultural production and community cooperation, play a crucial role in improving access to public services and strengthening the local economy. Effective utilisation of local resources, such as renewable energy and support for local businesses, can enhance the competitiveness and long-term viability of rural areas (Szymańska–Chodkowska-Miszczuk 2011).

Endogenous development provides rural communities with the opportunity to develop public services based on their resources, thus reducing dependence on central subsidies. The integration of local resources in the delivery of public services not only brings economic benefits but also strengthens community cohesion, as residents are actively involved in development processes (Atterton et al. 2011). In summary, effectively leveraging endogenous resources is crucial for enhancing the availability and quality of public services in rural areas, thereby promoting the sustainable development and stability of local communities.

Intrinsic resources play an essential role in social care and public services, especially at the level of rural communities. Local communities can rely on their own resources and social capital to organise and deliver services more efficiently, thereby improving the well-being and quality of life of their population. Social capital, which includes community cooperation and trust networks, is key to increasing the efficiency of public services and the success of local development processes (Dlouhá et al. 2022). Rural communities often face challenges such as limited resources and infrastructure. Endogenous resources, such as local agricultural production, small businesses and community initiatives, play a crucial role in addressing these challenges (e.g. mobile shops, participation of businesses in voluntary task provision, organisation of home-based medical care, etc.). The effective use of these types of resources not only brings economic benefits but also strengthens community cohesion, as residents are actively involved in development processes (Švihlová–Kubišová 2014). Overall, the integration of endogenous resources in the provision of social and public services is essential for the sustainable development and stability of rural areas.

Several factors, including economic, social and environmental factors, influence the population retention of settlements. Economic factors include job opportunities and the strength of the local economy, which are essential for retaining the population. A stable and diversified local economy makes a settlement more attractive by ensuring the livelihoods and quality of life of its residents (McGrail et al. 2017). Social factors such as community cohesion and social networks also play an essential

role. Strong community ties and community support systems strengthen the commitment of residents and reduce the propensity to migrate (Dyrting et al. 2020). Additionally, the availability of adequate public services – including healthcare, education and social welfare – is essential for retaining residents. Well-functioning, easily accessible services enhance both the attractiveness and the overall quality of life within a community (Mohammadiaghdam et al. 2020). Environmental factors such as natural endowments and environmental quality also influence the population retention capacity of a settlement. Municipalities with attractive natural assets are often better able to retain their inhabitants, as these assets contribute to the quality of life and overall well-being of residents (Hunter et al. 2005). Quality of life, which includes material and social security and the broadest possible coverage of public services, particularly health and education.

The quality of health services is a key factor driving urban out-migration. Inadequate health care in rural areas often prompts individuals to relocate to cities in search of better medical services (Mohammadiaghdam et al. 2020, McGrail et al. 2017). In contrast, well-equipped health facilities and easy access to services can keep people in their localities. A shortage of health professionals can also contribute to rural out-migration. Providing adequate health care is therefore essential to retain the population and strengthen rural communities. The quality of primary education services has a similarly significant impact on the out-migration of settlements. Families looking for better educational opportunities for their children often move to urban areas where higher-quality schools are located (Black 1999, Thissen et al. 2010). Teacher shortages and lower educational quality in rural schools may also contribute to out-migration. In contrast, high-quality education and well-resourced schools can make rural life more appealing. Therefore, improving the education system is essential to enhancing the population retention capacity of these settlements.

The presence of cultural and community services also plays a vital role in shaping the pattern of out-migration. Cultural programmes and community events can strengthen the cohesion of local communities, reducing the propensity to emigrate (Theodori–Theodori 2015). Settlements with a vibrant cultural scene and an active community life are likely to be more attractive to residents. In contrast, a lack of cultural programmes and weak community cohesion may drive out-migration. Developing cultural and community services is therefore essential to strengthen local communities. Municipal services, such as transport infrastructure and the quality of waste management, also have an impact on urban out-migration. Well-functioning transport networks and reliable municipal services can increase the attractiveness of settlements (Glasgow–Brown 2012). Accessible and efficient transport options are significant for daily life, as they facilitate travel to work and access to services. The quality of waste management and other municipal services also influences people's satisfaction and ability to stay in their local area. Improving municipal services is therefore key to retaining the population.

Description of the municipalities and data analysed

The study presents a comprehensive analysis of cross-sectional data on public services at the municipal level, with a particular focus on Hungarian rural municipalities, based on municipal data aggregated to the district level in 2021, which provides a detailed description of the availability, quality and efficiency of public services in the areas under study. The cross-tabulation analysis applied to the indicators under study reveals a feedback loop that allows for the compatibility of dependent and independent variables, providing a different perspective of analysis. In the present study, I examine population decline as an independent variable whose characteristics depend on the quality of accessibility of public services. However, cross-tabulation analysis of municipal data also revealed counter-selective mechanisms, typically shaped by the local economy, that prevent individuals of specific financial means and/or above a certain age from being mobile. For example, where there is a higher number of job seekers, there is a lower migration balance; thus, municipal unemployment is the factor acting against internal migration ($r = -0.303$, $p < 0.01$). Furthermore, where there is a higher income of business companies, there is a higher volume of migration ($r = 0.158$, $p < 0.05$). The study used principal component analysis (PCA) on county data, followed by multi-factor regression analysis and cluster analysis after aggregating data to the district level. PCA aims to reduce the data set and identify the main factors that have the most significant impact on the quality and availability of public services. Regression analysis was used to examine the extent to which the resulting indicators of public services in different groups of municipalities differ (dispersion of centrals) from each other. I checked the quality of the model fit using analysis of variance. Cluster analysis was then used to cluster districts with similar characteristics to make the different public service provisions and their characteristics comparable. A summary of the regression analysis results generated by the SPSS statistical software (see Table 1). This table presents key information on the model's fit quality, the proportion of variance explained by the explanatory variables and the extent of estimation error. The main components of the table and their significance are outlined below. The original data were sourced from the Hungarian Central Statistical Office, the National Health Insurance Fund and the National Tax and Customs Administration (NAV), among others. Municipal-level datasets were first harmonised by indicator category and subsequently aggregated to the district (*járás*) level using weighted averages or summations, depending on the variable's nature (e.g. per capita indicators vs. absolute volumes). The aggregation logic follows the administrative NUTS 4 district boundaries in effect as of 2021.

Results of the model regression test

Table 1 presents the results of the regression analysis conducted on the model, which examines the extent to which each social and community characteristic explains

variations in population holding power (headcount). The dependent variable is 'Zscore: soul balance', which is the difference in absolute value of the resident population. The independent variables are the z-score values of the different community and service indicators, which are:

Table 1

Model summary*

Model	R	R square	Adjusted R square	Standard error of the estimate
1	0.913[a)]	0.834	0.814	0.43183952

* Dependent variable: population balance (absolute value of the difference between the calculated field and the resident population) (persons)

a) Predictors (independent variables): (Constant) Z-score: Total registered readers in municipal libraries (persons); Z-score: Number of primary school educational facilities (number); Z-score: Total participants in educational events (persons); Z-score: Total participants in regular cultural education programs (persons); Z-score: Total participants in cultural events (persons); Z-score: General practitioner home visits, 2021; Z-score: Total cultural events (number); Z-score: Pediatric primary care home visits, 2021; Z-score: Total regular cultural education sessions (number); Z-score: General practitioner consultations at practice, 2021; Z-score: Total water supplied to households (1000 m³); Z-score: General practitioner care attendees, 2021; Z-score: Pediatric primary care consultations at practice, 2021; Z-score: Pediatric primary care physicians, 2021; Z-score: Total children enrolled in kindergarten (persons); Z-score: Pediatric primary care attendees and home visits, 2021; Z-score: Total sewage discharged from households through public sewers (1,000 m³); Z-score: Pharmaceutical turnover by prescription, 2021; Z-score: Pharmaceutical turnover by patient, 2021.

Table 2

Indicators and their content applied in the analysis

Indicator	Content
Enrolled readers in libraries	Number of readers enrolled in municipal libraries.
Primary school places of work	Number of places in primary schools.
Children enrolled in kindergarten	Number of children enrolled in kindergarten.
Participants in educational events	Number of participants in educational events.
Participants in cultural events	Number of participants in cultural events.
Participants in cultural forms	Number of participants in regular forms of cultural activities.
General medical care in the home	Number of patient visits to the home during GP care.
Cultural events	Number of cultural events.
Paediatric care	The number of people receiving care from a general paediatrician and the number of visits to the practice.
Use of public utilities	The amount of water supplied to households and the amount of wastewater discharged through public sewers are closely monitored.
Pharmaceutical distribution	Number of prescriptions and patients based on pharmaceutical sales.

- **R**: The correlation coefficient measures the strength of the relationship between the dependent variable and the predictor variables. Here, the value is 0.913, indicating a very strong positive relationship.

- **R square**: R square (R^2) is the ratio of explained variance, i.e. the extent to which the predictor variables explain the variance of the dependent variable. Here, R^2 is 0.834, which means that the predictor variables explain 83.4% of the variance of the dependent variable.
- **Adjusted R square**: Adjusted R^2 is the ratio of the explained variance corrected for the complexity of the model (the number of predictor variables). Here, the value is 0.814, which is notably high, indicating that the model fits the data well.
- **Standard error of the estimate**: The standard deviation of the forecasts indicates the extent to which the forecasts deviate from the actual values. Here, the value is 0.43183952.

The indicators were selected based on their documented relevance in prior studies concerning public service access and demographic trends in rural regions (e.g. Mohammadiaghdam et al. 2020, Kulcsár–Obádovics 2016). The selected variables encompass key domains, education, culture, healthcare and utilities, all of which significantly influence local quality of life and population dynamics. The results of the model show that the social, health, cultural and educational factors listed above have a significant impact on population change. The high R^2 and adjusted R^2 values suggest that the model fits the data well and reliably explains the dependent variable. On this basis, a clustering analysis (*k*-means cluster) can be carried out to classify the districts under study into categories.

Based on the results of the preliminary hierarchical cluster analysis, four main groups appear to emerge among the districts. When naming the clusters, it is worth taking into account the characteristics of the clusters that most distinguish them from each other.

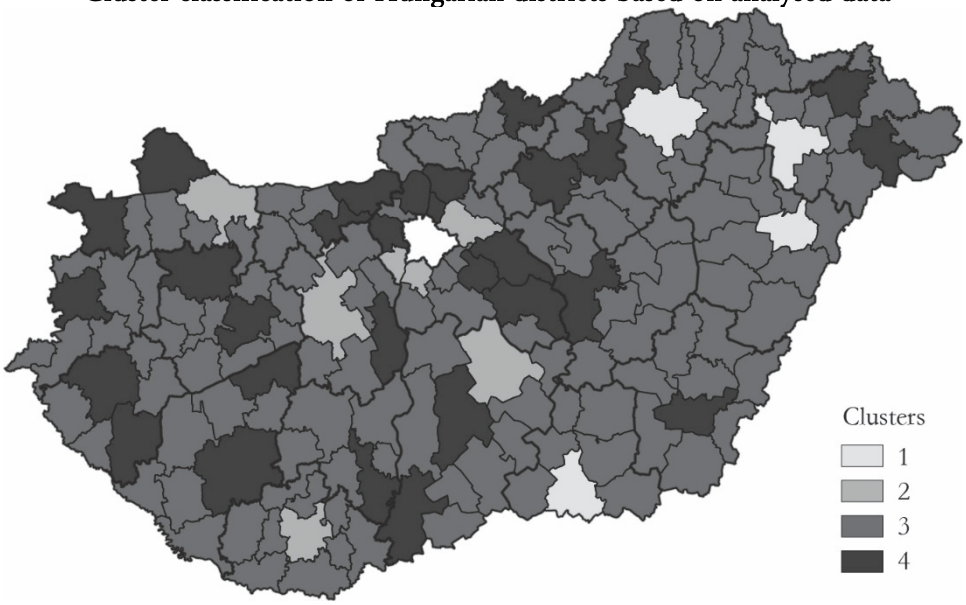
Table 3

Clusters and indicators

Indicators	Developed healthcare and service infrastructure settlements (cluster 1)	High population density, moderate healthcare provision settlements (cluster 2)	Low population density, limited healthcare and service infrastructure settlements (cluster 3)	Balanced, medium service level settlements (cluster 4)
Pharmaceutical sales	High	Medium	Low	Medium
General practitioner and pediatric care	High	Medium	Low	Medium
Number of kindergarten and nursery places	Many	Medium	Few	Medium
Resident population	High	High	Low	Medium
Social catering and day care for the elderly	Significant	Moderate	Few	Moderate
Number of registered jobseekers	Low	Medium	High	Moderate
Birth rate	High	Medium	Low	Moderate

Figure 1

Cluster classification of Hungarian districts based on analysed data



From the ANOVA results, we can see that the different clusters show significant differences in health care, demographics, public services and economic indicators. Below, I propose four cluster names that can be distinguished based on key characteristics. To understand the homogeneity of data content between districts within a cluster, considering the above aspects, Table 4 (the so-called ANOVA) is provided.

Contact details

Mean square (cluster): A measure of the variance between clusters. This value is the sum of squares divided by the degrees of freedom of the clusters. This value indicates the extent to which the average of each cluster differs from the overall average. A higher value reflects a greater difference between clusters.

Mean square (error): Measures the residual variance that lies outside the differences between clusters. This value is the *sum* of *squares* divided by the *degrees* of *freedom* of *the* error. This value shows how much the data varies within the mean of the clusters. Smaller values indicate that most of the variance can be explained by differences between clusters, whereas larger values indicate substantial residual variance.

F-value: Measures the residual variance, which is outside the differences between clusters. This value is the sum of squares divided by the degrees of freedom of the

error. This value shows how much the data varies within the mean of the clusters. Smaller values indicate that most of the variance can be explained by differences between clusters, whereas larger values indicate substantial residual variance.

Sig. (p-value): The level of significance, which shows how likely differences between variables are to be due to chance.

The following variables are significantly different between clusters ($p < 0.05$):

Table 4

Cluster-level variance analysis for 2021 indicators

	ANOVA					
	cluster		error		F	Sig.
	mean square	degrees of freedom	mean square	degrees of freedom		
Z-score: Natural population change (per 1,000), 2021	4.178	3	0.948	170	4.409	0.005
Z-score: Resident population (December 31), 2021 (persons)	4.842	3	0.011	170	485.541	0
Z-score: Domestic migration balance per thousand inhabitants (per 1,000), 2021	3.107	3	0.962	170	3.23	0.024
Z-score: Pharmaceutical turnover/ patient traffic, 2021	51.173	3	0.115	170	446.527	0
Z-score: Pediatric primary care consultations, 2021	48.008	3	0.17	170	281.664	0
Z-score: Pediatric primary care physicians, 2021	49.625	3	0.142	170	349.698	0
Z-score: General practitioner care attendees, 2021	49.176	3	0.15	170	328.184	0
Z-score: General practitioners, 2021	48.749	3	0.157	170	309.781	0
Z-score: Specialized nurses in general practitioner care, 2021	46.784	3	0.192	170	243.6	0
Z-score: Operating nursery places (methodology valid from 2017), 2021 (number)	2.944	3	0.01	170	285.055	0
Z-score: Total children enrolled in kindergarten (persons)	50.266	3	0.131	170	384.902	0
Z-score: Total primary school classes in daytime education (number)	49.703	3	0.141	170	353.681	0
Z-score: Total municipal libraries (number)	6.496	3	0.903	170	7.194	0
Z-score: Total persons receiving day care for the elderly (persons)	11.778	3	0.81	170	14.544	0
Z-score: Total persons receiving social meal services (persons)	33.081	3	0.434	170	76.247	0
Z-score: Total household gas consumers (number)	49.376	3	0.146	170	337.485	0
Z-score: Total municipal waste collected (tons)	49.451	3	0.145	170	341.105	0

Table 5

Indicators and explanations

Indicator	Value	Explanation
Natural reproduction, population change (per 1,000)	$F = 4.458$, $p = 0.005$	Significant differences exist in the natural reproduction and population change between clusters.
Resident population (December 31) (persons)	$F = 145.744$, $p < 0.001$	Significant differences exist in the population size between clusters.
Domestic migration balance per capita (per 1,000)	$F = 3.230$, $p = 0.024$	Significant differences exist in the domestic migration balance between clusters.
Prescription drug consumption (patients)	$F = 146.327$, $p < 0.001$	Very significant differences exist in prescription drug consumption between clusters.
Pediatric care (patients)	$F = 261.684$, $p < 0.001$	Very significant differences exist in pediatric care between clusters.
Number of general practitioners	$F = 245.868$, $p < 0.001$	Very significant differences exist in the number of general practitioners between clusters.
Number of patients treated by general practitioners	$F = 306.184$, $p < 0.001$	Very significant differences exist in the number of patients treated by general practitioners between clusters.
Number of general practitioners in training	$F = 243.600$, $p < 0.001$	Very significant differences exist in the number of general practitioners in training between clusters.
Operating daycare spots (2017–2018 method) (places)	$F = 226.005$, $p < 0.001$	Very significant differences exist in the number of operating daycare places between clusters.
Kindergarten children (persons)	$F = 328.704$, $p < 0.001$	Very significant differences exist in the number of kindergarten children between clusters.
Primary school grades in daytime education (classes)	$F = 393.031$, $p < 0.001$	Very significant differences exist in the number of primary school grades between clusters.
Municipal libraries (number)	$F = 7.184$, $p < 0.001$	Significant differences exist in the number of municipal libraries between clusters.
Elderly receiving home care services (persons)	$F = 14.544$, $p < 0.001$	Significant differences exist in the number of elderly receiving home care between clusters.
Participants in social meals (persons)	$F = 76.247$, $p < 0.001$	Significant differences exist in the number of participants in social meals between clusters.
Number of household gas consumers	$F = 337.455$, $p < 0.001$	Significant differences exist in the number of household gas consumers between clusters.
Total transported municipal waste (tons)	$F = 341.105$, $p < 0.001$	Significant differences exist in the total amount of transported municipal waste between clusters.

The ANOVA table shows that there are significant differences between clusters for all the variables tested. This indicates significant differences between the groups across the various clusters based on the indicators used.

Table 6

Distances between final cluster centres

Cluster	1	2	3	4
1		6.787	15.094	11.456
2	6.787		9.667	5.945
3	15.094	9.667		3.845
4	11.456	5.945	3.845	

From the above, it is evident that the clusters differ significantly in terms of health care, demographics, public services and economic indicators. Based on their primary characteristics, the districts can be categorised into four distinct clusters. The data analysed include indicators on the accessibility and quality of public health, education, culture and social services, among others. The study aims to identify the links between public services and the demographic, economic and social characteristics of settlements and to identify factors and good practices from the international literature that can improve the accessibility and quality of public services in rural areas.

The selected indicators and their relevance

The demographic composition and ageing of the population significantly affect the demand for and availability of public services in rural areas. As rural populations age, the need for health and social care services rises (Mohammadiaghdam et al. 2020). Meanwhile, the taxpayer base that funds public services is shrinking due to the out-migration of younger generations (Brown–Argent 2016). Together, declining population and an ageing population increase the problems of access to public services, as providers are often unable to maintain the necessary infrastructure (Thissen et al. 2010, Ahern–Hine 2012, OECD 2021). The mobility constraints of older populations make local access to public services particularly important, but often challenging in rural areas (Ahern–Hine 2012). Meanwhile, accessing public services due to a lack of mobility may not only be a challenge for elderly or very elderly citizens in ageing areas, but also for impoverished populations (Kulcsár–Obádovics 2016). Therefore, innovative solutions, such as mobile health services, are becoming increasingly crucial for elderly care (Montayre et al. 2022).

Cultural events play an essential role in the life of local communities by promoting social cohesion and strengthening local identity. Therefore, innovative solutions, such as mobile health services, are becoming increasingly crucial for elderly care (Negruşa et. al. 2016). Additionally, these events have a positive economic impact by attracting tourists and stimulating the local economy (Torre–Scarborough 2017). Such events provide an opportunity for community participation and a valuable way to spend

leisure time, which further increases residents' satisfaction and commitment to the municipality.

These analyses provide an opportunity to better understand the public service challenges in rural municipalities and strategies to improve the efficiency of services and the quality of life of residents.

Meanwhile, the outward migration balance can be associated with prosperity and regions offering better earning potential. The pattern shown in Figure 2 closely resembles the spatial distribution of wage levels. This provides visualisation support for the statistical results. It shows that low wages/living standards are a significant motive for emigration.

This can also be related to consumption and, thus, waste production (Figure 3) (Szabó–Végh 2023). Thus, the visual representation reveals a similar pattern between wage levels and consumption (waste production), as well as between welfare and migration, which, beyond statistical tests, supports the causal relationship. Comparing the map showing the wage bill and the migration balance (Figure 4), it can be seen that regions with higher wage bills (e.g. Budapest and its surroundings and Western Hungary) have a positive migration balance, suggesting that these areas attract labour. Conversely, regions with lower wage costs, especially in the east and south of the country, have a negative migration balance, indicating out-migration.

The analysis below uses data for the year 2021 to explore the correlations between the various socio-economic indicators. The analysis draws essential conclusions based on the strength and direction of the correlations between the various factors, in particular with regard to the links between social infrastructure and economic performance.

The analysis of the inward migration balance reveals that this indicator is negatively correlated with the number of registered job seekers ($r = -0.303$, $p < 0.01$). Thus, the visual representation reveals a similar pattern between wage levels and consumption (waste production), as well as between welfare and migration, which, beyond statistical tests, supports the causal relationship. However, there is a positive relationship with entrepreneurial income ($r = 0.158$, $p < 0.05$), indicating that areas with higher entrepreneurial income have a higher propensity to migrate, probably due to a broader range of economic opportunities.

The number of day-care places in operation also shows a strong positive correlation with several other indicators, such as the number of day-care places ($r = 0.990$, $p < 0.01$), the number of job seekers ($r = 0.849$, $p < 0.01$) and the number of cultural events ($r = 0.625$, $p < 0.01$). These data suggest that where there are more day-care places, other community services and opportunities are more available. A similar trend can be observed for nursery school places, which have a strong positive relationship with nursery school places ($r = 0.990$, $p < 0.01$), the number of jobseekers ($r = 0.875$, $p < 0.01$) and the number of cultural events ($r = 0.591$, $p < 0.01$). This indicates a strong correlation between the availability of educational

infrastructure and other community services, suggesting that communities with more advanced day-care centres tend to have a broader range of services available. Furthermore, the very strong correlation ($r = 0.990$) between nursery and crèche places suggests that the development of educational infrastructure is closely linked to different levels of provision for children. This also shows that these infrastructures are not developing in isolation but as part of an integrated system.

An analysis of the number of job seekers confirms that this indicator is positively related to the number of places in nurseries and kindergartens and the number of cultural events. This suggests that a higher number of job seekers may be to some extent related to the availability of social infrastructure and the richness of community life. The latter may be because local social needs, such as the childcare needs of workers, often drive the development of social infrastructure.

Economic indicators, such as wage costs from personnel ($r = 0.843$, $p < 0.01$) and business income ($r = 0.743$, $p < 0.01$), are also strongly associated with the number of places in nurseries and kindergartens and the number of cultural events. This suggests that economic well-being is closely linked to the availability of social services, and that together they strongly determine the quality of life in local communities. Economic indicators (wage costs and business income) are strongly positively correlated with the number of places in nurseries and kindergartens and the number of cultural events. This suggests that increasing economic prosperity is stimulating the development of social services. The results show that economic prosperity and access to social services together shape the quality of life in local communities. Regions with higher wage costs and higher business incomes can provide better quality social services, which directly contribute to the well-being of their population.

The analysis of cultural and community life reveals a close link between the number of cultural events and regular cultural activities and the number of places in nurseries and kindergartens, as well as wage costs and business income. This confirms that the richness of community life and social infrastructure is mutually reinforcing.

Indicators for health services, such as pharmaceutical sales and home-based paediatric care, also show a strong relationship with the number of nursery and kindergarten places, the number of job seekers and wage costs. This suggests that the availability and quality of health services play a fundamental role in shaping the development of other socio-economic factors. The analysis thus clearly shows how the interaction between social infrastructure and economic indicators affects the development of local communities and their ability to retain their population. The combined analysis of social and economic factors is essential for the effective planning of regional development strategies and local public services.

Figure 2

Expenditure on personal expenses: total wage costs in 2021

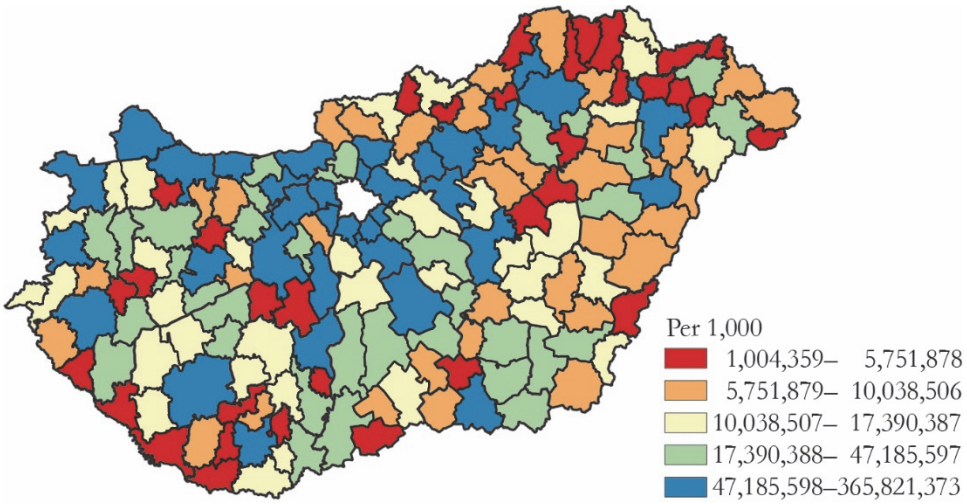


Figure 3

Total transported municipal waste in 2021

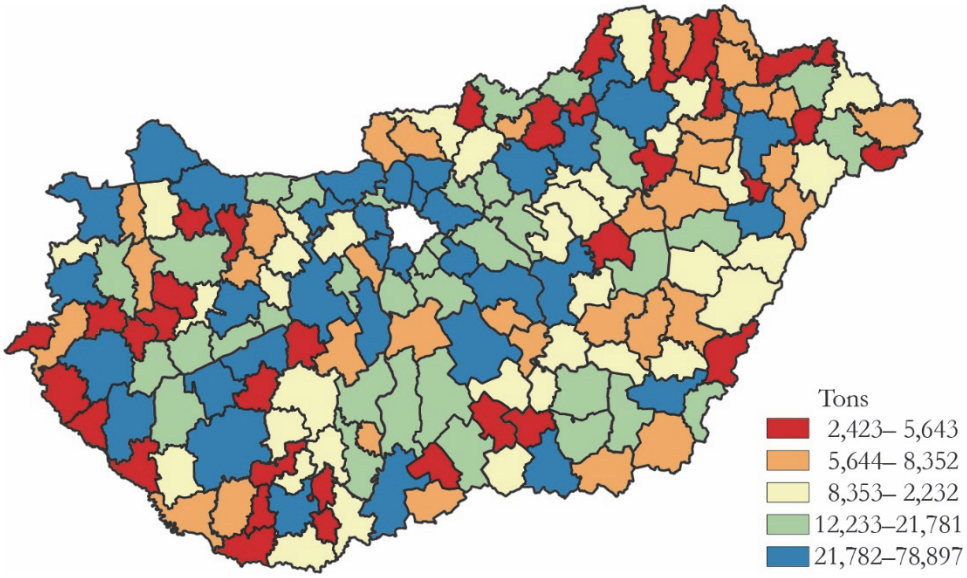
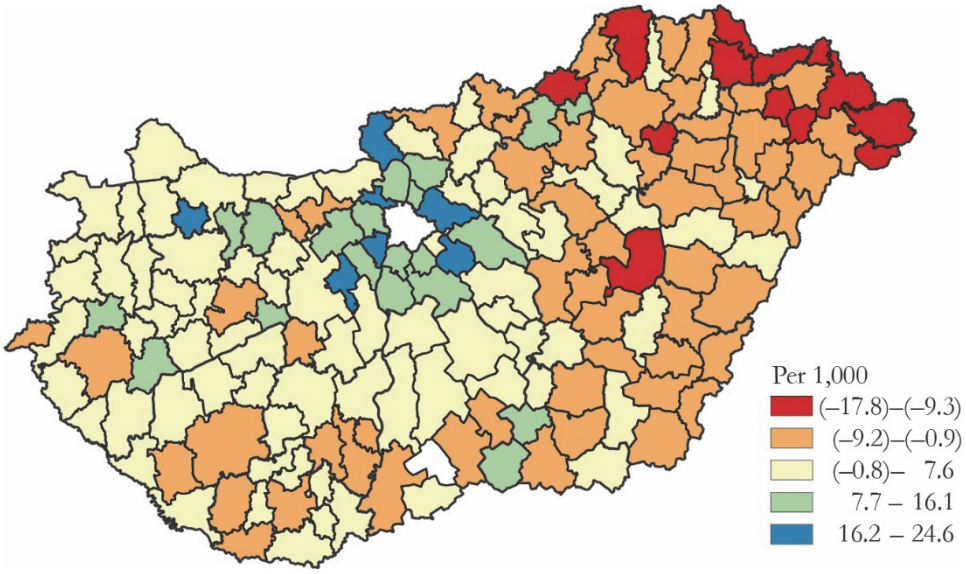


Figure 4

Internal migration balance per 1,000 inhabitants, 2021



Summary

The results show that social and economic indicators are closely linked. Access to education, health and cultural services is often associated with economic well-being. Strong correlations indicate that areas with greater availability of these services generally experience more favourable economic and social conditions.

The population balance map shows that the most significant natural decrease is concentrated in the southeastern and South Transdanubian regions (Figure 5). In contrast, a positive natural increase is primarily observed in certain districts of the West Transdanubian and the northeastern regions. This distribution may be related to the quality of health, education and municipal services, as well as local economic conditions and employment opportunities (OECD 2021, Davis 2016). Higher infant mortality and lower health care provision in more backwards regions may also contribute to negative natural increase (Johnson–Lichter 2019, Kulcsár–Obádovics 2016).

Figure 5

Natural population growth and decline in 2021

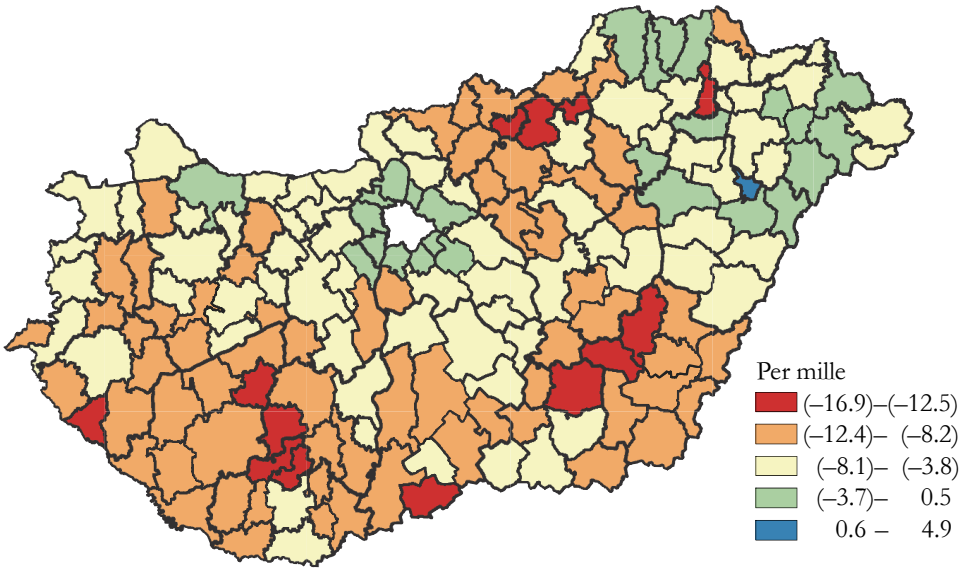
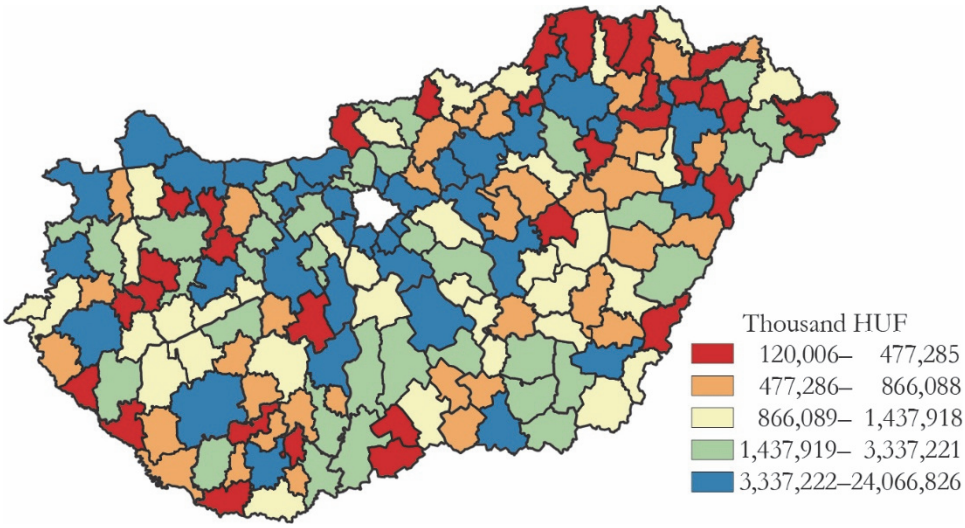


Figure 6

Total revenue from local industrial taxes by local governments in 2021



Higher fertility rates in poorer municipalities are due to several factors. In low-income areas (Figure 6), educational and family planning opportunities are often limited, leading to less effective birth control (McQuillan 2004). In these communities, childbearing often serves as a form of social and economic security, as

children are expected to contribute to the family's income later in life (OECD 2021). Furthermore, cultural and religious norms may also play a role in encouraging larger families (Verma–Taegen 2019). Kulcsár–Obádovics (2016) highlights that in poorer communities, childbearing is often a means of social status and community recognition, which may also encourage larger families. The better indicators in the northeast and east are due to the presence of an overrepresented Roma population in the resident population and the high reproductive rate associated with them. In these communities, childbearing often serves as a form of social and economic security, as children are expected to contribute to the family's income later in life. The districts of Zala and Baranya are less reproductive due to their fragmented and ageing settlement structure. Meanwhile, the southern part of Bács-Kiskun shows unfavourable values due to a lower population density (and of course also ageing). The same is true for the eastern tip of Nógrád and the northern districts of Heves. They also have in common the fact that the municipalities' business tax revenues are lower. Therefore, the number of potential employer present is lower than in the districts with more favourable values.

In each figure, the relationships between the inward migration balance, the number of nursery places, and the number of cultural events are examined. The maps and analyses indicate that areas with greater availability of these public services generally exhibit higher economic potential and lower inward migration (Figures 2–4). These visualisations support the statistical results obtained in the studies, which show that there is a strong correlation between better access to public services and economic stability. From the above, it can be concluded that the maps and charts taken together show that the availability and quality of public services are closely linked to population retention and economic stability, especially in rural areas. Meanwhile, looking at the last two charts (Figures 5–6), the thematic maps show that the patterns reveal an opposite effect between the out-migration balance of the districts in Northeastern Hungary and the individual indicators of fiscal vitality. One possible explanation for this is that the more unfavourable the fiscal vitality of a municipality, the less population movement is observed. This may be explained by the fact that, in the absence of active economic activity, immobility arises either from an ageing resident population or from the fiscal constraints faced by a working-age population in an unfavourable financial situation.

The results of the multivariate statistical analysis confirm that the availability and quality of public services are strongly correlated with economic indicators and demographic dynamics. The regression model demonstrated a high explanatory power ($R^2 = 0.834$), suggesting that service-related variables such as access to health care, education and cultural infrastructure can significantly influence population retention capacity. This reinforces previous research findings that accessible services enhance local cohesion and increase settlement attractiveness (Mohammadiaghdam et al. 2020, Kulcsár–Obádovics 2022).

Discussion

Regression evidence. The model summary (see Table 1) indicates a very strong association between the service-related predictors and population retention ($R = 0.913$; $R^2 = 0.834$, adj. $R^2 = 0.814$; std. error = 0.432). This means that roughly 83% of the variance in the dependent variable ('Z-score: soul balance') is explained by the set of community and service indicators. In substantive terms, settlements embedded in richer service ecologies – health, education, culture and utilities – display systematically higher demographic resilience. While the model aggregates multiple domains, the high adjusted R^2 indicates that its explanatory power is not merely an artefact of overfitting but rather reflects a meaningful signal in the data.

Bivariate correlations and direction of effects. The inward migration balance is negatively correlated with the number of registered job seekers ($r = -0.303$, $p < 0.01$) and positively correlated with entrepreneurial income ($r = 0.158$, $p < 0.05$). Substantively, higher joblessness is associated with reduced in-migration and increased out-migration pressure, consistent with a mobility constraint mechanism under adverse local labour market conditions. Conversely, areas with higher business income likely offer broader opportunity sets, attracting movers and/or retaining residents. These effects dovetail with the thematic maps (see Figures 2–6), where wage mass, local tax revenues and waste volumes (as a proxy of consumption intensity) co-locate with favourable migration balances.

Service co-location and infrastructure complementarity. Strong positive co-movements of educational capacity indicators (e.g. nursery and kindergarten places; $r \approx 0.990$) with cultural events/participation and health-related measures point to infrastructure complementarity rather than isolated provision. In practice, when childcare capacity expands, other service pillars also tend to grow, creating a bundled effect that enhances both the attractiveness of settlement and the feasibility of daily life (work–care compatibility, access to primary care and cultural participation). This is consistent with the regression pattern: multidomain service intensity aligns with population retention.

Cluster and ANOVA evidence. The clustering solution yields four different district-level profiles. The ANOVA results (see Table 4) show statistically significant between-cluster differences across all tested indicators ($p < 0.05$), confirming that clusters are substantively distinct in terms of health, education, cultural and economic dimensions. Distances between final cluster centres (see Table 6) further corroborate separation. Interpreting clusters through the maps (see Figures 2–6) suggests a gradient: The Budapest agglomeration and Western Hungary concentrate economic potential and service density, coupled with positive migration balances, whereas parts of Eastern and Southern Hungary face weaker fiscal vitality, sparser service networks and less favourable demographic dynamics.

Scale and competitiveness. Results imply a two-way linkage: where economic potential concentrates, both population and public service intensity rise; in turn,

denser service ecologies reinforce locational attractiveness. Therefore, public service coverage above NUTS 3 level can be treated as a proxy indicator of territorial competitiveness – it both signals and supports competitive positions in the spatial economy. This aligns with the observed patterns in wage mass, local business tax revenues and net migration.

Mechanisms and equity. The combined patterns indicate a cumulative advantage in strong regions, characterised by virtuous cycles of economy, services and demography, and a cumulative disadvantage in other areas. Endogenous resources and social capital may ameliorate service gaps, but the data indicate that structural constraints (thin labour demand, ageing, fiscal limits) sustain path dependence. For lagging districts, policy must co-target labour market revitalisation and baseline service guarantees (primary care, childcare, transport) to break immobility traps.

Limitations and robustness. Two cautions follow. First, the analysis is conducted on district-level aggregates while the research question targets settlement-level dynamics; ecological fallacy risks remain. Second, we report strong correlations and model fit; future work should provide standardised regression coefficients (β), confidence intervals and VIFs to document effect sizes, uncertainty and multicollinearity. Despite these caveats, the convergent evidence from regression analyses, correlations, clustering, ANOVA and mapping triangulates the core claim: service-rich, economically dynamic territories retain their populations more effectively.

Conclusion

The findings of this study highlight the critical interplay between public service provision, economic capacity and population retention in rural Hungary. The results show that municipalities with more extensive and accessible educational, cultural and healthcare services are better positioned to maintain demographic stability – particularly where these services are embedded within a context of strong local economic activity.

Rather than viewing public services as merely supporting infrastructure, the analysis suggests they are strategic drivers of territorial competitiveness. The spatial co-location of high service intensity, strong economic performance and positive migration balances indicates that public services not only respond to but also actively shape demographic and economic patterns. In this sense, service provision is both a proxy and a mechanism of spatial advantage.

Taken together, the high adjusted R^2 (0.814), the directionally consistent correlations (e.g. a strong negative association between job seekers and in-migration, $r = -0.303$, $p < 0.01$ and a positive association between entrepreneurial income and migration, $r = 0.158$, $p < 0.05$) and the statistically significant. ANOVA-based cluster distinctions provide strong quantitative evidence supporting the conclusion that economic potential and public service density co-evolve with demographic resilience.

For policy, this implies a dual mandate: (1) in economically stronger districts, continue to reinforce service ecosystems that sustain demographic resilience, and (2) in lagging districts, prioritise investments in childcare, primary health care and community–cultural infrastructure as catalysts for economic revitalisation. These service pillars should be integrated with targeted labour-demand measures to prevent the amplification of cumulative territorial disadvantages.

Future research could enhance this analysis by incorporating longitudinal data, qualitative insights into service perception and a more granular (settlement-level) spatial resolution. Nonetheless, this study contributes to the growing body of evidence that equitable access to public services is not only a matter of social justice but also a cornerstone of sustainable regional development.

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