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Fotografija na naslovnici: Luči naselij osvetljujejo pokrajino v okolici Kranja na severozahodu Slovenije (fotografija: Xseon, Shutterstock.com).

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SPATIAL DISTRIBUTION OF SOCIAL INNOVATION POTENTIAL IN DISADVANTAGED AREAS: THE CASE OF TWO HUNGARIAN COUNTIES

Krisztina Varga, Géza Tóth

Mád, a settlement in a developing district of Borsod-Abaúj-Zemplén county.

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Krisztina Varga[1], Géza Tóth[1]

Spatial distribution of social innovation potential in disadvantaged areas: The case of two Hungarian counties

ABSTRACT: Social innovation has emerged as a strategic tool to foster development in disadvantaged areas. The study analyzes the spatial distribution and temporal changes of social innovation potential and its link to population dynamics in two disadvantaged Hungarian counties. Using indicators classified into input, output, and impact categories, a composite index was constructed for municipalities over three census years (2001, 2011, 2022). Moran I statistics and clustering tested spatial dependence of social innovation potential and the relationship between clusters and migration balance. Findings show positive spatial autocorrelation weakened over time. A strong link exists between social innovation potential and migration balance, with innovative settlements showing lower outmigration.

KEYWORDS: social innovation potential, population changes, migration balance, Moran I statistic, disadvantaged area, Hungary

Prostorska razporeditev potenciala za družbene inovacije na območjih z razvojnimi omejitvami: primer dveh madžarskih županij

POVZETEK: Družbene inovacije so se uveljavile kot strateško orodje za spodbujanje razvoja na območjih z razvojnimi omejitvami. Članek analizira prostorsko razporeditev in časovne spremembe potenciala za družbene inovacije ter njegovo povezavo z gibanjem prebivalstva v dveh madžarskih županijah z razvojnimi omejitvami. Na podlagi kazalnikov, razvrščenih v kategorije izhodišč, rezultatov in učinkov, je bil oblikovan sestavljeni indeks za občine v treh popisnih letih (2001, 2011 in 2022). Z Moranovo statistiko I in razvrščanjem v skupine je bila preverjena prostorska odvisnost potenciala za družbene inovacije ter povezava med skupinami in selitvenim saldom. Izsledki kažejo, da je pozitivna prostorska avtokorelacija v opazovanem časovnem intervalu oslabela. Obstaja močna povezava med potencialom za družbene inovacije in selitvenim saldom, saj je za inovativna naselja značilna nižja stopnja odseljevanja.

KLJUČNE BESEDE: potencial za družbene inovacije, prebivalstvene spremembe, selitveni saldo, Moranova statistika I, območje z omejitvenimi dejavniki, Madžarska

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[1] University of Miskolc, Miskolc, Hungary
krisztina.varga.t@uni-miskolc.hu (https://orcid.org/0000-0001-7112-8800), geza.toth@ksh.hu (https://orcid.org/0000-0002-9233-1899)

1 Introduction

In recent years, social innovation has become an increasingly prominent concept in regional development, especially in addressing spatial inequalities and revitalizing disadvantaged and peripheral areas. Social innovation is increasingly understood as a systemic, multi-actor, and iterative process embedded in institutional and structural contexts, analogous to technological and economic innovation (Dawson and Daniel 2010; Cajaiba-Santana 2014; Veresné Somosi and Varga 2021; Varga and Tóth 2024). Broadly, it encompasses novel and effective responses to unmet societal needs, aiming to enhance community well-being, cooperation, and local capacities (Szendi 2018; Varga and Tóth 2021). Based on the literature review, social innovation can be defined as a process that, beyond measures aimed at improving living standards, encompasses the emergence of new structures, the stimulation of societal agency, as well as both top-down policy mechanisms and bottom-up civic initiatives. Consequently, it enables a dual-perspective approach that can be assessed through input, output, and impact indicators. Within this context, social innovation potential refers to the aggregate of institutional, human, and economic capacities that enable a locality to initiate and sustain socially innovative practices (Benedek et al. 2015; Varga et al. 2023). These capacities are spatially uneven and rooted in structural and demographic legacies.

Past studies examined social innovation processes, stakeholders, and their relation to technological innovation, with a focus on measuring social innovation potential and its link to competitiveness (Varga and Tóth 2021; Nagy and Tóth 2021; Varga and Tóth 2024). We adopt the widely accepted view that social innovation addresses needs unmet by the market and can provide alternative pathways to development in lagging regions (Benedek et al. 2015; Bosworth et al. 2016; Szendi 2018; Vercher 2022). In Hungary's most disadvantaged settlements, these needs are associated with unemployment, educational inequalities, health challenges, and poor housing. These areas suffer from low population retention, underdeveloped infrastructure, low-income levels, and a negative migration balance. The local economy is weak and lacks innovation capacity. In such contexts, social innovation is critically needed (Woolcock 1998; Mumford et al. 2002; Hazel and Onaga 2003; Mulgan et al. 2007; Pol and Ville 2009; Young 2011; European Commission 2013; Castro Spila et al. 2016; Unceta et al. 2016; Kleverbeck et al. 2019; Varga et al. 2023; Varga and Tóth 2024).

Social innovation potential is not identical to social innovation itself but represents its preconditions – such as institutional infrastructure, human and social capital, and local governance – that together define a locality's innovativeness and adaptability (Cajaiba-Santana 2014; Szendi 2018; Kleverbeck et al. 2019; Varga and Tóth 2021). Settlements with high social innovation potential are more likely to mobilize local actors, foster participation, and develop cross-sectoral collaboration. These capacities support resilience, improve quality of life, and can enhance both competitiveness and population retention. In contrast, areas with low social innovation potential may reinforce social inequality and suffer continuous decline.

As Nemes Nagy (2006) argues, spatial structures are relatively stable in the short term, with significant changes occurring only over medium (10–15 years) or long-term horizons. While this issue has been explored theoretically (Schmitz et al. 2013; Castro Spila et al. 2016), empirical studies remain scarce (Benedek et al. 2015; Szendi 2018; Nagy and Tóth 2019).

Our approach draws on a narrower economic interpretation of spatial structure, focusing on the distribution of economic activity. Spatial configuration affects macroeconomic growth by concentrating benefits and externalities, both positive (e.g., economies of scale) and negative (e.g., congestion, high land prices) (Varga 2005). In line with Hungarian literature, we define territorial development using per capita income, which best reflects local conditions and is widely accessible (Nemes Nagy et al. 2001; Németh 2008; Pénzes 2014). While unemployment data once served as a complementary measure (Lőcsei 2010; Tóth and Nagy 2013), its utility has declined with the rise of public work schemes. Few empirical efforts have explored the social innovation potential and development nexus (Szendi 2018; Nagy and Tóth 2019). We also include settlement size as a variable, given its relevance to spatial structure.

Based on literature, methods for measuring social innovation primarily focus on assessing macro-level social innovation processes (Cajaiba-Santana 2014; Carvache-Franco et al. 2018; Varga et al. 2023; Cunha et al. 2024). Although macro-level initiatives dominate, methods aimed at quantifying the processes and impacts of local and regional efforts are emerging with increasing intensity. Building on the reviewed literature and our previous research (Varga et al. 2020; Varga and Tóth 2021; Veresné Somosi et al. 2023), a research gap can be identified that motivates further investigations. We revisit the municipalities of two

Hungarian counties to determine whether spatial patterns of social innovation potential show regularity or randomness, and whether they correlate with migration and development outcomes.

Our current analysis examines the measurement and spatial distribution of social innovation potential in two disadvantaged counties, using census data from 2001, 2011, and 2022. This time frame allows us to track temporal changes and compare them with earlier findings, while raising new questions. We analyze social innovation potential alongside demographic processes, particularly internal migration, to better understand why certain disadvantaged areas show greater resilience to depopulation. Our primary research question is: To what extent is there a spatially observable relationship between social innovation potential and the migration balance of municipalities in disadvantaged areas? We also explore whether social innovation potential can alter spatial structural patterns.

Based on previous findings, two of Hungary's most structurally disadvantaged counties – Borsod-Abaúj-Zemplén and Szabolcs-Szatmár-Bereg – were selected to examine the spatial distribution of social innovation potential, since social innovation can be identified as a new tool and model for fostering the convergence of disadvantaged peripheral regions.

2 Literature review

Based on prior analyses of local, regional, and national measurement approaches (Veresné Somosi and Varga 2021; Varga and Tóth 2024), various efforts have been made to evaluates social innovation processes and capacities. Despite these efforts, a universally accepted methodology remains absent (Cajaiba-Santana 2014; Szendi 2018). Initial frameworks primarily relied on economic indicators; however, the core aim of social innovation – enhancing well-being – requires a broader, more integrated approach (Hochgerner 2011). Measurement frameworks should account for rural specificities (Bosworth et al. 2016; Vercher 2022; Varga and Tóth 2024) and the systemic nature of innovation (Dawson and Daniel 2010; Carvache-Franco et al. 2018; Neumeier 2017; Cajaiba-Santana 2014; Benedek et al. 2015; Szendi 2018).

Academic discourse increasingly highlights social innovation's potential in addressing regional inequalities, especially in peripheral areas (Neumeier 2017; Veresné Somosi and Varga 2021). In line with European Union (EU) cohesion policy, social innovation is regarded as a key instrument for reducing disparities (Ewers and Brenck 1992; Benedek et al. 2015; Szendi 2018; De Palo et al. 2018; Widuto 2019).

The measurement of social innovation involves evaluating inputs, outputs, and impacts, with emphasis on societal outcomes. Current methodologies focus on assessing social innovation potential – the capacities enabling innovation (Benedek et al. 2015; Szendi 2018; Kleverbeck et al. 2019; Nagy and Tóth 2019; Varga et al. 2023) – as distinct from the contextual prerequisites required for its emergence (Szendi 2018; Varga et al. 2023).

Table 1: Methods used to measure social innovation based on a structured review of the literature (based on Veresné Somosi and Varga 2021; Varga and Tóth 2024).

LOCAL MEASUREMENT	REGIONAL MEASUREMENT	NATIONAL MEASUREMENT
Social Innovation Indicators (IndiSI project, Kleverbeck et al. 2019) *data collection without calculation*	Regional Innovation Capability (IndiSI project, Kleverbeck et al. 2019) *elaboration of indicators without calculation*	European Social Innovation Index (ESII) *pilot study without calculation*
Social innovation capacity (Schmitz et al. 2013) *data collection without calculation*	Regional Vulnerability Index (SIMPACT project, Castro Spila et al. 2016) *development of indicators without calculation*	Blueprint of Social Innovation Indicator (TEPSIE project, Schmitz et al. 2013) *pilot study without calculation*
Measurement of social innovation process according to Triple Bottom Line (Dainiené and Dagiliené 2016) *elaboration of indicators without calculation*	Regional social innovation potential (Benedek et al. 2015) *Examination of 15 micro-regions (social innovation potential)*	Measuring social impact (OECD, Eurostat 2018) *pilot study without calculation*
Complex social innovation index (Szendi 2018) *Survey of 610 localities (social innovation potential)*	Regional Social Innovation Index (RESINDEX) *282 regional organisations*	Social Innovation Index (SII) *Survey of 45 countries (ranking)*

The methodological approaches for measuring social innovation rely on the use of different indicators at various measurement levels. The individual methods may vary by country, primarily due to the differing range of available data. There are general recommendations that can primarily be applied to national-level measurements. A significant portion of the calculations attempt to adapt the indicators involved in macro-level studies for local and regional measurement. Different measurement methods are interconnected in a hierarchical system, although there are discrepancies in the indicators used. In the structured review of the literature, we examined four methods at each level, which are detailed in Table 1.

3 Methods

The methodological chapter describes the analytical process in three main steps (Figure 1). First, the indicators are defined, forming the basis for measuring social innovation potential. This is followed by an examination of the spatial distribution of the indicators, which enables the identification of regional disparities and temporal changes. Finally, the analysis addresses the relationship with migration processes, revealing the connection between social innovation and demographic dynamics.

3.1 Establishing and analysis of the indicators

Based on the literature (Kocziszky 2004; Schmitz et al. 2013; Benedek et al. 2015; OECD, Eurostat 2018; Szendi 2018; Kleverbeck et al. 2019; Nagy and Tóth 2019; Varga et al. 2020; Veresné Somosi et al. 2023), an indicator system and a social innovation potential indicator can be defined to support the measurement of social innovation concerning the municipalities of the examined counties. In this case, we applied the indicator system compiled based on literature for measuring social innovation. Its complexity requires a multidimensional measurement framework. Following research and development evaluation models (OECD, Eurostat 2018), input, output, and impact indicators are used to capture different stages of the process. Inputs reflect foundational conditions (e.g., institutions, employment, education); outputs represent immediate results (e.g., participation, service uptake); impacts cover long-term effects (e.g., income, quality of life, attitude shifts). This threefold structure is especially relevant in disadvantaged regions, where traditional economic metrics may overlook key aspects of local development and resilience (Varga et al. 2023).

In our study, each group included seven indicators. When compiling the indicator system, it was necessary to consider that the indicators do not always point in the same direction; that is, there are indicators where an increase is positive, while for others, a decrease is viewed favorably. For indicators where lower values signify a favorable situation, we calculated the inverse of the indicators. As for the averages of the input, output, and impact indicator groups, a comprehensive indicator measuring social innovation potential can be determined. We normalized the indicators within each indicator group to ensure that our data, which varies in scale, can be compared with one another. We calculated the average of the normalized data for each indicator group. No weighting was performed during the calculations.

The indicators selected as input, output and impact indicators are presented in Table 2.

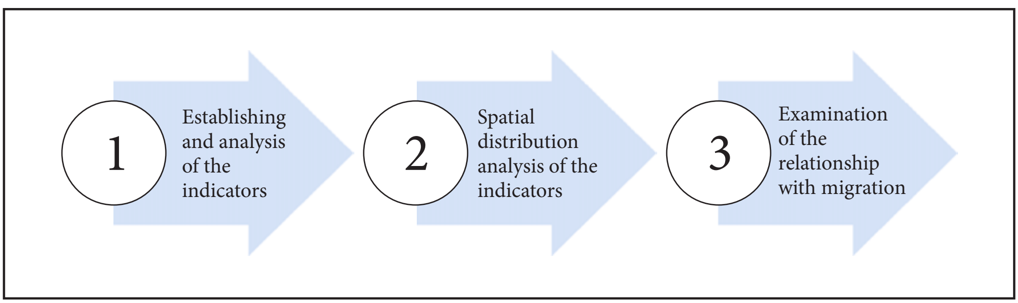


Figure 1: The structure and logic of the methodological framework.

Table 2: Indicators for the input, output and impact indicator group (based on Varga et al. 2023).

INPUT INDICATOR GROUP	INDICATORS
institutional factors	1. number of non-profit enterprises per 1000 inhabitants (2001, 2011, 2022)
locational factors	2. number of active enterprises per 1000 inhabitants (2001, 2011, 2022)
human factors	3. child population as a percentage of the resident population (2001, 2011, 2022) 4. elderly per 100 children (2001, 2011, 2022) 5. dependency ratio (children (0–14 years) and elderly population (>65 years) as a percentage of the population aged 15–64) (2001, 2011, 2022) 6. proportion of the population aged 7 and over with primary education (including those who have not completed school) (2001, 2011, 2022)
activity factors	7. employment rate (2001, 2011, 2022)
OUTPUT INDICATOR GROUP	INDICATORS
economic factors	1. ratio of public employees to the population aged 15–64 (2006, 2011, 2022)
cultural factors	2. number of participants in cultural events per 1000 inhabitants (2001, 2011, 2022)
social factors	3. average amount used for child protection allowances (2006, 2011, 2022) 4. number of individuals receiving social meals per 1000 inhabitants (2001, 2011, 2022) 5. number of individuals receiving home assistance per 1000 inhabitants (2001, 2011, 2022) 6. unemployment rate (2001, 2011, 2022)
health factors	7. patient flow per family doctor and pediatrician (2001, 2011, 2022)
IMPACT INDICATOR GROUP	INDICATORS
factors of social conditions	1. per capita income (1000 HUF) (2001, 2011, 2022) 2. proportion of the population aged 7 and over with a high school education and above (2001, 2011, 2022)
family factors	3. proportion of single person households (2001, 2011, 2022) 4. proportion of families with three or more children (2001, 2011, 2022)
perception of safety factors	5. number of registered crimes per 1000 inhabitants (2001, 2011, 2022)
factors of social infrastructure	6. number of places in long-term residential care per 1000 inhabitants (2001, 2011, 2022)
factors of environmental conditions	7. municipal green area per 1000 inhabitants (2008, 2011, 2022)

In order to examine the internal dynamics of social innovation potential over time, a pair-wise correlation analysis was conducted between the social innovation potential indicator and its three component dimensions: input, output and impact indicators. As referred to above, the complex indicator of social innovation potential was calculated as the arithmetic average of the normalised values of the input, output and impact dimensions, without applying any further weighting.

The pair-wise correlation coefficients (r^2 values) were also calculated between the same components in consecutive years (2001–2011, 2011–2022 and 2001–2022) and for the social innovation potential complex indicator itself. This approach allowed us to examine:

- how strongly each component correlates with itself over time (persistence over time),
- whether the overall social innovation potential indicator remains stable or changes structurally over the periods.

3.2 Spatial distribution analysis of the indicators

Furthermore, we aimed to examine the spatial distribution of social innovation potential and sought to determine whether any regularities, spatial patterns, or instead a random distribution could be observed. To test spatial dependency, we applied Moran's I statistic. Like all spatial autocorrelation tests, Moran's I starts with the null hypothesis that there is no spatial dependence in the sample. This is what we explored. The formula for Moran's I (Equation 1) is as follows (Moran 1948):

$$I = \frac{n}{2A} * \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}\delta_{ij}(y_i-\bar{y})((y_j-\bar{y})}{\sum_{i=1}^{n}(y_i-\bar{y})^2} \quad \text{(Equation 1)},$$

where n is the number of settlements, y_i represents the social innovation potential in each settlement, $\bar{y}$ is the arithmetic mean of the social innovation potential, A denotes the number of neighborhood connections, and the coefficient δ_{ij} equals 1 if i and j are neighbors, otherwise, it is 0 (Dusek 2004; Dusek and Kotosz 2016).

For interpreting the data, it is important to consider that the calculated indicator should be understood within the following ranges and manner:
$I > -1/(N-1)$ → positive spatial autocorrelation,
$I = -1/(N-1)$ → no spatial autocorrelation,
$I < -1/(N-1)$ → negative spatial autocorrelation.

In the next step, we aimed to examine the spatial pattern in more detail. Following Anselin (1995), research on spatial autocorrelation emerged, often referred to in international literature as LISA (Local Indicators of Spatial Association).

Anselin (1995), by introducing Moran's I, developed one of the most widely used methods for quantifying and visualizing spatial autocorrelation: Local Moran's I statistic. According to the notation introduced by Getis and Ord (1996), the definition of I is given in Equation 2:

$$I_i = \frac{Z_i-\bar{Z}}{S_Z^2} * \sum_{j=1}^{N}\left[W_{ij} * (Z_i - \bar{Z})\right] \quad \text{(Equation 2)},$$

where $\bar{Z}$ is the average of all units, Z_i is the value of unit i, Sz^2 is the variance of the Z variable across all examined units, and W_{ij} is the distance weight factor between units i and j, derived from the neighborhood matrix W.

For determining the neighborhood matrix, we applied the so-called queen contiguity criterion, meaning that settlements are considered neighbors if they share either an edge or a corner.

For the obtained Local Moran's I values:
- negative values indicate negative autocorrelation,
- positive values indicate positive autocorrelation.

However, the function's range extends beyond the *[−1, +1]* interval.

The Local Moran's I statistics are useful for identifying areas that are like or different from their neighbors. The higher the Local Moran's I value, the stronger the spatial similarity. Conversely, a negative value suggests that the spatial distribution of variables approaches randomness.

The scatter plot categorizes settlements into four groups based on their quadrant placement:
1. High–High (HH): areas with high values where the neighboring units also have high values.
2. High–Low (HL): areas with high values surrounded by low-value neighbors.
3. Low–Low (LL): areas with low values where the neighboring units also have low values.
4. Low–High (LH): areas with low values surrounded by high-value neighbors.

The groups labeled with odd numbers indicate positive autocorrelation, while those with even numbers indicate negative autocorrelation. Choosing Local Moran's I as a local spatial autocorrelation indicator is particularly useful when identifying spatial outliers. It reveals:
- where HH and LL values cluster in space, indicating regions with strong spatial similarity,
- where HL and LH areas appear, highlighting territorial units that significantly differ from their neighbors.

3.3 Examination of the relationship with migration

Drawing on the clusters identified by Local Moran's I statistics, the relationship between social innovation potential and migration was systematically examined. Social innovation potential – as previously noted – can be understood as a proxy for well-being. In line with earlier studies (Lockley et al. 2008; Wright 2012; Moralli 2023; Varga et al. 2023), the analysis of migration provides an empirically grounded way to understand how people perceive well-being, which underlies their mobility decisions. Building on this rationale, our study examines whether social innovation potential clusters are quantitatively linked to internal migration patterns: is there a measurable relationship between social innovation potential (as a quasi-well-being indicator), people's perceptions of it, and resulting migration decisions. Recent research underscores why this linkage is critical (Moralli 2025). Methodologically, mixed-method approaches combining quantitative migration modeling with qualitative insights deliver deep, context-rich evidence. Moreover, advanced quantitative tools such as network analyses of migration flows and multilevel modeling illuminate how spatial clusters of social innovation potential influence movement dynamics (Salamońska 2022). Our investigation advances understanding of how social innovation capacity impacts population retention and movement – and vice versa.

4 Results and discussion

4.1 Spatial and temporal shifts in social innovation potential

Our findings indicate a substantial transformation in the social innovation potential of municipalities between 2001 and 2022, as past data do not correlate with recent data (Table 3). The most significant shifts occurred in input indicators. Declining correlation values – particularly for input indicators and the overall social innovation potential – indicate growing spatial divergence and imply that the structural determinants of social innovation have substantially changed over time.

Table 3: Pair-wise correlations between social innovation potential and its components (r^2).

Indicators	2001/2011	2011/2022	2001/2022
Input indicators	0,548	0,154	0,005
Output indicators	0,214	0,258	0,164
Impact indicators	0,457	0,390	0,234
Social innovation potential	0,575	0,395	0,222

After reviewing the indicator system – based on the composite indicator measuring social innovation potential, determined from the averages of the input, output, and impact indicator groups – the 2022 situation shows that the most favorable conditions are found in the two county seats and the settlements within their spheres of influence. In contrast, the settlements in the most disadvantaged positions are primarily peripheral villages. This pattern is consistent with several findings in the international literature on centre-periphery and migration issues (Avdić et al. 2022; Ljubenović et al. 2025) and our previous findings, as is the fact that input indicators play the most significant role in shaping the level of social innovation potential, as their values are the highest for most settlements. In this regard, our findings are entirely consistent with our previous research (Nagy and Tóth 2021; Varga and Tóth 2021). The composite indicator confirms that, although the most advantaged settlements within the two counties are relatively scattered across space, the proximity to major cities plays a clear role. The most disadvantaged settlements are primarily those near the national border, but in many cases, settlements along county borders also exhibit similarly unfavorable conditions (Figure 2 and 3).

4.2 Spatial clustering of social innovation potential

The Moran I statistic was used to test for spatial dependence. The global spatial autocorrelation of social innovation potential, covering all settlements in the two counties, in 2022 was: I = 0.230 (in 2001, I = 0.393; in 2011, I = 0.334).

Based on this, we can determine that the phenomenon exhibits positive spatial autocorrelation (I = −1/(577-1) = −0.00174), meaning that the spatial concentration of similar values is higher than what would be expected due to natural processes. Settlements with high social innovation potential tend to have high-value neighbors, while settlements with low values tend to be surrounded by other low-value settlements.

Using Local Moran's I, we conducted calculations on social innovation potential at the settlement level for 2022. To analyze whether the high degree of similarity is driven by the concentration of high or low values of the variable, we compared the Local Moran's I results with the initial data using Moran scatter plots.

As a next step, we plotted the standardized values of the observation units on the horizontal axis of the diagram, while the vertical axis represented the corresponding standardized Local Moran's I values (i.e., the average values of neighboring units).

Based on their placement in the respective quadrants of the scatter plot, the municipalities categorized into four groups can be presented as follows:

- The HH cluster primarily includes the most advantaged settlements, with a total of 57 settlements. Most of these are part of the Miskolc agglomeration and the Nyíregyháza urban area (both are cities with county status). Beyond these two groups, Sárospatak and two neighboring settlements, as well as some villages in the Kisvárda region, also belong to this cluster. However, urban status alone does not guarantee inclusion in the HH cluster, as several cities in the two counties do not belong to any cluster at a 95% significance level.
- The LL cluster consists of 37 settlements, representing the most disadvantaged areas of the two counties. Within this cluster, two distinct groups emerge: the external peripheries along the national border (e.g., Lónya, Barabás, Hidasnémeti, Pusztaradvány), and the internal peripheries near county borders (e.g., Szabolcs) and settlements far from urban centers (e.g., Vaja, Porcsalma), which also face significant disadvantages.
- The LH cluster includes 13 settlements, primarily located near HH cluster settlements. Among the most substantial are Tunyogmatolcs and Sajópetri.
- The HL cluster consists of 17 settlements, primarily neighboring areas with low social innovation potential. The most significant among them are Csengersima and Krasznokvajda.

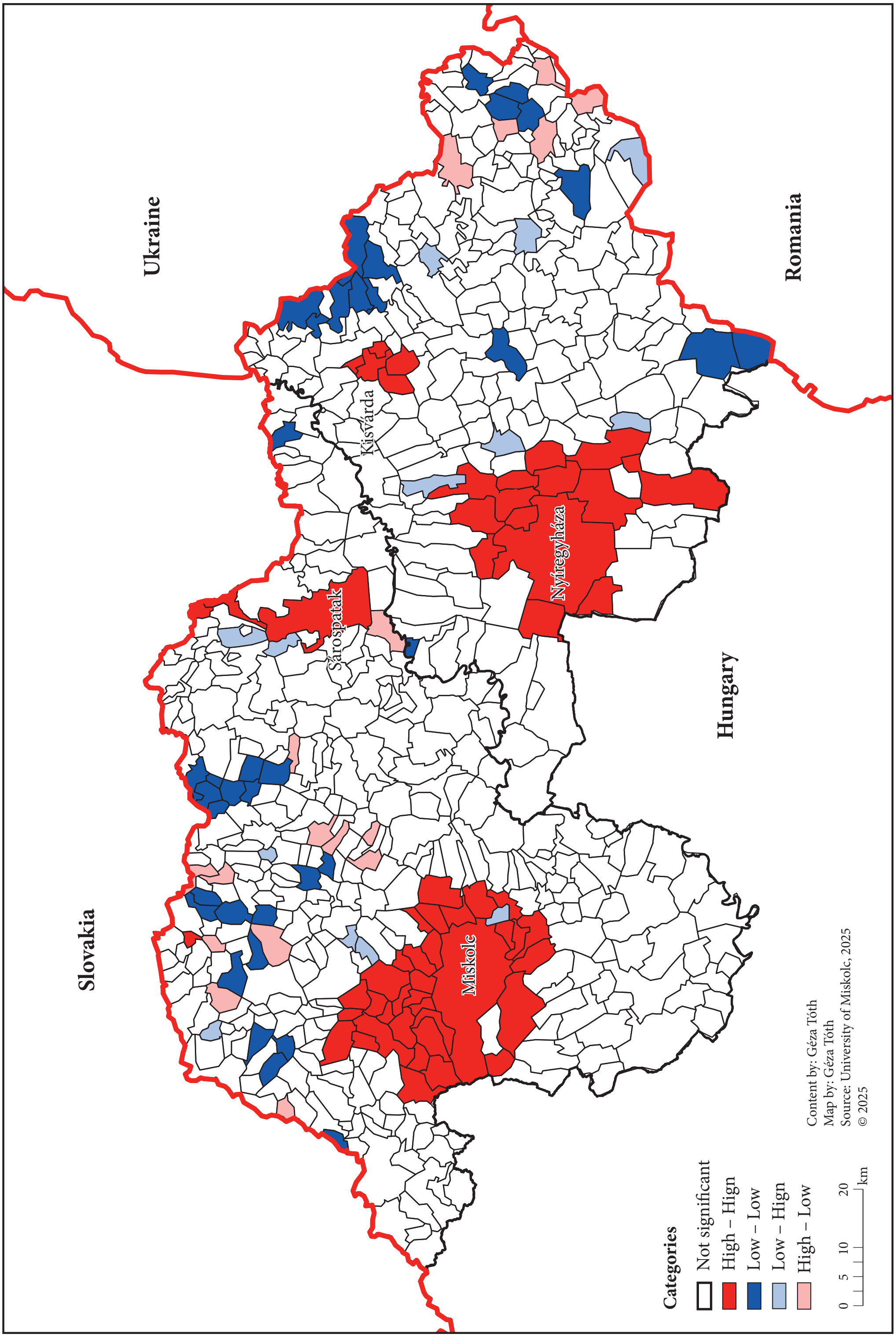
Building on earlier studies (Nagy and Tóth 2021; Varga and Tóth 2021), the overall spatial structure of social innovation potential remains consistent; however, the number of settlements within each cluster has particularly increased. Given the absence of methodological changes and the observed decline in global spatial autocorrelation, this trend points to the emergence of localized clusters with similar innovation dynamics. To assess cluster stability, a bivariate spatial autocorrelation analysis was conducted, comparing 2022 values with neighboring settlements' 2001 data (Figure 2, Figure 3).

Minor spatial shifts were observed in the cluster dynamics. In Sárospatak, the absence of significant similarity with its surroundings in 2001 – due to neighboring settlements' low innovation potential – suggests improvements in adjacent areas over time (Borsod-Abaúj-Zemplén county). In regions such as the Cserhát, Rakaca Basin, and Torna Hills, several settlements remained in LL or HL clusters, while others lost statistical significance, reflecting stagnation or modest improvement (Borsod-Abaúj-Zemplén county). Conversely, in the vicinity of Mátészalka (e.g., Nyírmeggyes, Kocsord), former HH cluster settlements lost statistical significance by 2022, indicating a relative decline in innovation potential, while modest improvement is observed in the neighboring settlements of Kisvárda (Szabolcs-Szatmár-Bereg county).

4.3 The impact of social innovation potential on migration

We examined how belonging to different clusters is reflected in the migration balance. It was found that there is a clear relationship between cluster membership and the magnitude of migration balance. HH cluster settlements have the lowest outmigration, while LL cluster settlements experience the highest outmigration. In this case, it can be concluded that there is a fundamentally strong and positive relationship between social innovation potential and migration balance. However, in the case of the two outlier clusters (LH, HL), this relationship is much less evident (Table 4, Figure 4).

Figure 2: Local Moran's I of the composite indicator measuring social innovation, 2022. ➤ p. 56
Figure 3: Bivariate Local Moran's I of the composite indicator measuring social innovation, 2022/2001. ➤ p. 57


Ukraine
Romania
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Hungary
Kisvárda
Nyíregyháza
Sárospatak
Miskolc
Categories
Not significant
High – Hign
Low – Low
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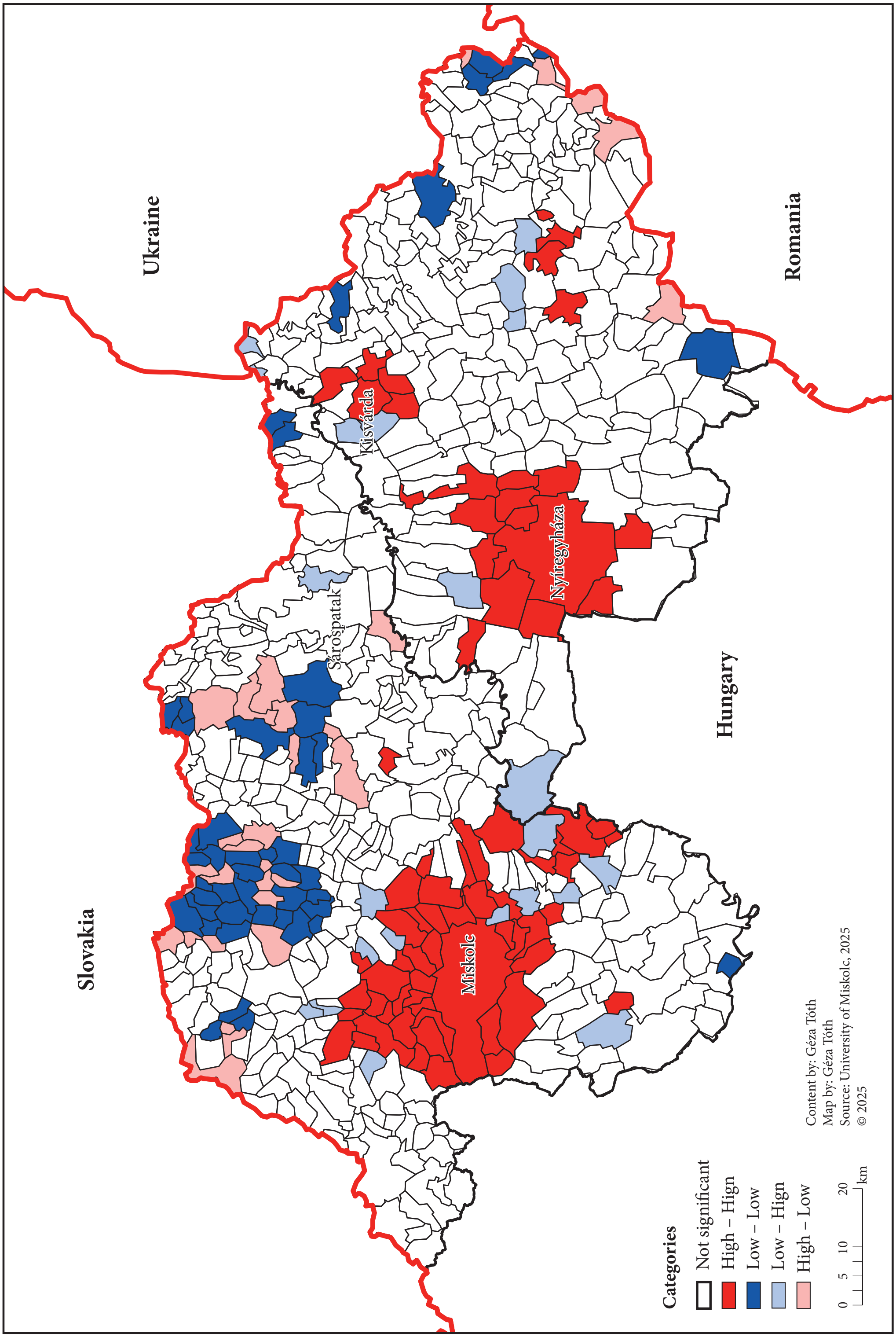
High – Low
0 5 10 20 km
Content by: Géza Tóth
Map by: Géza Tóth
Source: University of Miskolc, 2025
© 2025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Content by: Géza Tóth
Map by: Géza Tóth
Source: University of Miskolc, 2025
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Table 4: Migration balance per 1,000 inhabitants in the examined clusters.

Clusters	1990–1999	2000–2009	2010–2019	2020–2022	1990–2022
Not significant	−4,3	−6,2	−8,0	−7,6	−6,2
High–High	−2,7	−4,0	−3,8	−4,7	−3,6
Low–Low	−8,2	−9,6	−10,5	−14,9	−9,9
Low–High	−3,3	−5,5	−11,1	−9,5	−6,8
High–Low	−3,0	−5,6	−9,0	−7,0	−6,0
Average	−3,8	−5,5	−6,5	−6,7	−5,3

Across all clusters, negative trends are prevalent, with the LL cluster experiencing the most pronounced decline over time. Some clusters, especially LH and HL, exhibit fluctuations, indicating periods of instability or short-term improvements that were not maintained. In contrast, the High-High cluster showed greater stability, with gradual declines over the years, but without the sharp drops observed in other clusters.

The data reveals a consistent decline across all clusters, with the most significant decrease observed in the LL cluster (areas with low values where the neighboring units also have low values). While regions with high innovation potential have generally seen less drastic declines, the overall trend indicates that social innovation potential has weakened in most areas over the time periods examined. This suggests a need for targeted interventions to address the challenges faced by the most disadvantaged regions.

LL and LH clusters require targeted interventions to reverse negative trends, HL regions need policies to fully realize their innovation potential, and HH clusters benefit from measures that sustain or modestly enhance it.

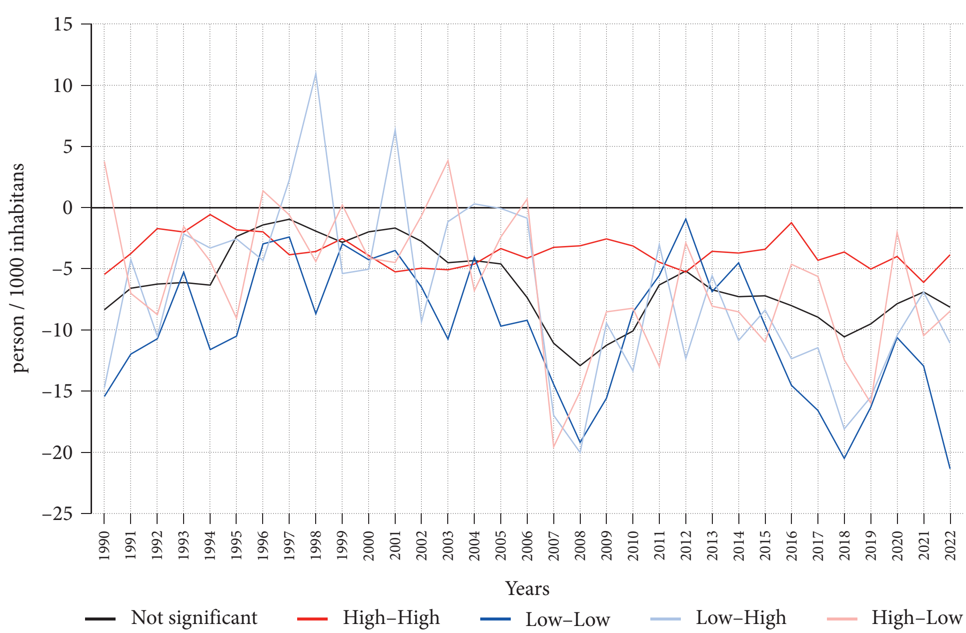

Figure 4: Migration balance per 1,000 inhabitants in the examined clusters.

4.4 Discussion

The results of the study provide important insights into the spatial dynamics of social innovation potential and its relationship with demographic trends in two disadvantaged Hungarian counties. However, beyond the general trends and clusters identified, several methodological and interpretative considerations deserve attention. The study used a carefully selected composite set of indicators, comprising 21 variables in three main categories: input, output and impact indicators. Although this three-dimensional structure reflects the systemic nature of social innovation – similar to technological or economic innovation processes – it is important to recognise the different levels of sensitivity and explanatory power between these dimensions.

Notably, the input indicators proved to be the most volatile and determinant over time, while the impact indicators showed greater stability over time. Output indicators fell in between. These differences highlight the need for greater selectivity in the use of indicators: future research and policy evaluation efforts should favour indicators that are theoretically sound and empirically sensitive to local changes. In disadvantaged regions, where data gaps are common and overly complex, composite indicators may mask rather than clarify meaningful differences.

The proposed use of the variables of social innovation potential indicator is presented in Table 5.

Table 5: Proposed use of the variables of social innovation potential indicator.

Indicator group	Example of variables	Analysis framework	Proposed use
Input	employment rate, number of nonprofits, age structure, education level	strongly reflects local dynamics	for short- and medium-term policy design and trend analysis
Output	participation in cultural activities, social services uptake	indicates activation and short-term effects	to monitor program implementation or early-stage impact
Impact	per capita income, crime rate, housing quality	captures structural outcomes	for long-term evaluation, complement with contextual analysis

Further examination of intra-county differences is crucial. Key tasks include analyzing settlements with slightly lower social innovation potential than county seats, targeting border areas lacking social foundations with locally tailored programs, identifying stakeholders, planning resources, and fostering communication and institutional support (Dusek and Szalka 2012; Schmitz et al. 2013; Veresné Somosi and Varga 2018; Kleverbeck et al. 2019; Cappellano et al. 2022; Varga et al. 2023). Additionally, linking measurement levels and methods, and assessing the long-term impact of social innovation initiatives (Varga et al. 2020; Cunha et al. 2024; Tóth and Varga 2024; Schwab Foundation … 2025), may reveal important correlations and explain outlier clusters. A clear limitation of the current study is the scope of available indicators and the lack of a deeper examination of the relative positional changes of individual settlements. Reflecting these relative positional changes in terms of migration balance remains a subject for further research. The key question is whether declining positions coincide with the settlements most affected by outmigration in the counties and to what extent an improving position translates into a more favorable migration situation over time. While spatial statistical methods identify patterns, social innovation is inherently qualitative and context-dependent, shaped by local actors, norms, and networks (Mulgan et al 2007; Veresné Somosi and Varga 2018; Schwab Foundation … 2025; Bresciani et al. 2025). Future research should integrate embedded case studies and qualitative methods within HH, LL, HL, and LH categories to explore the mechanisms behind observed spatial patterns, including institutional drivers in HH areas or latent capacities in LL areas, and to explain gaps in HL and LH municipalities.

5 Conclusion

Based on our latest study of settlements in Borsod-Abaúj-Zemplén and Szabolcs-Szatmár-Bereg counties, we conclude that the social innovation potential of settlements has changed between 2001 and 2022. Due to the relatively slow changes in spatial processes, we aimed to analyze a longer time span. This approach allows for a comparison between our previous studies and current research while also providing a foundation for assessing the direction and extent of these changes. The most striking transformation is observed in the input indicators (institutional, locational, human, and activity factors), suggesting that the resources and conditions underlying social innovation have partially changed. The most significant shifts are primarily visible in the demographic and employment conditions of the settlements.

Our research also showed a correlation between social innovation potential and the population retention capacity of settlements in the two examined counties. In settlements with improving social innovation potential, less population decline was observed during the analyzed period, indicating that more socially innovative settlements are more attractive to residents. Our analysis revealed a correlation between social innovation potential and migration balance in the two disadvantaged counties of Hungary. Settlements with higher social innovation potential experienced lower emigration rates, reinforcing the idea that social innovation plays a crucial role in the population retention capacity of settlements. Conversely, settlements with worsening positions exhibited the highest emigration rates.

Overall, the research results confirm that social innovation is a key factor in the development and population retention of settlements. The promotion of social innovation may contribute to reducing spatial inequalities and supporting the integration of lagging settlements, reaffirming our previous research findings. According to the reviewed literature (Moulaert and Nussbaumer 2005; McNeill 2017; Lipták 2019; Castro-Arce and Vanclay 2020; Alina 2023) and our earlier studies (Varga et al. 2023; Varga and Tóth 2024), the social innovation potential of settlements aligns with their current development status. However, social innovation may generate positive transformation potential in the medium term, in line with slow-changing spatial processes. Investing in, promoting, and strengthening social innovation has a fundamental impact on competitiveness and, ultimately, on improving quality of life.

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