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Reshaping Regions: A Silent Divergence Deepening Inequalities in Slovakia

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Abstract

Migration plays a crucial role in reshaping regional socioeconomic disparities, particularly in post-socialist countries. This study examines migration patterns and their role in reinforcing spatial polarization in Slovakia. It aims to identify key economic, infrastructural, and demographic factors influencing migration trends and to assess their long-term impact on regional development. The study employs spatial panel econometric models to analyze district-level migration data in Slovakia spanning from 2002 to 2022. It utilizes migration efficiency indices, attraction efficiency indices, and gross migration balance rates in combination with economic variables: unemployment, GDP per capita, housing prices, and population structure. Spatial regression models account for spatial autocorrelation and interdependencies across districts. Findings indicate persistent west-east polarization, with Bratislava and western regions gaining population due to economic opportunities and suburbanization, while eastern Slovakia faces continued out-migration linked to economic stagnation and infrastructural deficiencies. Spatial effects show migration trends are significantly influenced by neighbouring districts, thus reinforcing cumulative regional advantages and disadvantages.

Key words: *migration, regional disparities, spatial econometrics, migration efficiency, suburbanization, economic polarization, human capital*

1. INTRODUCTION

Migration profoundly reshapes regional socioeconomic landscapes, influencing labour markets, population structures, and urbanization. As a key factor of regional development, it redistributes human capital, potentially enhancing economic efficiency by better aligning workforce supply with demand. However, migration can also exacerbate regional disparities, often favouring urban centres over rural or economically weaker areas. The migration patterns within Slovakia, both domestically and internationally, over the last twenty years highlight this divide, especially between the western and eastern parts of the country. This study analyzes these spatial patterns and their underlying factors, with a focus on how migration efficiency and attraction contribute to regional inequalities in Slovakia.

Slovakia‘s post-socialist transformation, marked by market economy adoption and EU accession since the early 2000s, offers a valuable case study for migration analysis. These changes have spatially reshaped economic opportunities, infrastructure, and demographic mobility. Urbanization and suburbanization are concentrated in the Bratislava metropolitan area, attracting skilled migrants due to its economic dynamism. Conversely, eastern Slovakia experiences persistent population decline due to limited economic prospects and structural disadvantages. While general migration patterns in Slovakia have been studied, the complex interplay between spatial autocorrelation, migration efficiency, and socioeconomic factors requires further investigation.

The literature lacks a comprehensive analysis of migration‘s role in reinforcing spatial polarization and regional development inequalities in Slovakia. While economic factors (wages, unemployment, housing) and non-economic factors (infrastructure, demographics, suburbanization) are acknowledged, systematic analyses of migration efficiency using spatial econometrics, considering both time trends and regional interdependencies, are limited. This study addresses this gap by employing spatial panel models to evaluate the economic and demographic factors of migration patterns across Slovakia‘s districts spanning 2002 to 2022.

This study addresses: (1) the spatial characteristics and long-term migration trends in Slovakia; (2) the influence of economic, infrastructural, and demographic factors on migration efficiency and attraction; and (3) the regions benefiting from or disadvantaged by migration, identifying the key factors. The corresponding research questions are: (RQ1) Does the Bratislava region exhibit consistent net migration gains due to economic opportunities and suburbanization? (RQ2) Does eastern Slovakia experience sustained out-migration due to economic stagnation and infrastructure limitations? (RQ3) Does migration selectivity, especially regarding age and education, intensify regional demographic polarization?

Comprehending these migration dynamics is vital for policymakers and regional planners, given their impact on economic development, public service provision, and regional sustainability. Eastern Slovakia‘s persistent out-migration hinders economic revitalization, while Bratislava‘s rapid suburban growth strains infrastructure and challenges urban planning. Effective policy interventions, focusing on regional labour market improvements, infrastructure investment, and balanced urbanization, are essential.

This article proceeds with: a theoretical review of migration, focusing on post-socialist spatial dynamics and socioeconomic factors; a materials and methods section detailing data and statistical techniques, including migration efficiency indices and spatial regression models; a results section presenting empirical findings on migration trends, spatial disparities, and their factors; a discussion contextualizing these findings within theoretical and policy frameworks; and a conclusion summarizing key findings, suggesting future research directions, and recommending policies to address migration-driven regional inequalities in Slovakia.

2 THEORETICAL FRAMEWORK

Migration significantly reshapes regional landscapes by influencing demographics, economic vitality, and population distribution, driven by governance, social networks, technology, and individual factors, and is central to regional development and urbanization (Pavlík et al., 1986; Rees et al., 2017). It restructures regional demographics, altering age, education, and labour force dynamics (Rees et al., 2017; Ernst et al., 2023). While migration intensities correlate with national development (Bell et al., 2015), its redistributive impact in Europe varies regionally (Rowe et al., 2019), driving labour market and economic disparities (Rees & Sander, 2020). In Slovakia, driven by economic disparities, housing, and familial motivations, exhibits an east-to-west and rural-to-urban flow, mirroring post-socialist Central and Eastern European trends (Musil, 1993; Sýkora 2009; Ouředníček, 2007; Ilnicki, 2020; Thomas, 2013; Hejduková & Kureková, 2020; Halás & Klapka, 2021). This migration, marked by unique Roma community and return migrant patterns, necessitates understanding its spatial and socioeconomic factors (de Haas, 2011), with empirical studies confirming post-transformation concentration in metropolitan regions (Novotný et al., 2023); the significant influence of distance, education, population, and especially housing (Lichner et al., 2024), age and education-based spatial polarization (Pregi & Novotný, 2019), Bratislava‘s concentration and decentralization, moderated by economic crises (Novotný, 2016), and the role of housing and family motives in driving migration, particularly to affluent suburban districts (Baláž et al., 2023).

Economic Factors of Migration and Regional Disparities

Migration is primarily driven by socioeconomic factors, including job opportunities, housing, and income disparities (Pavlík et al., 1986; Divinský, 2009; Jurčová, 2010), with higher wages and job prospects in urban areas attracting migrants from less prosperous regions (Feijten & Mulder, 2010), a trend confirmed by econometric analyses showing the influence of wage and unemployment differentials (Hejduková & Kureková, 2020). Post-socialist transitions, as in Slovakia, reshaped economic opportunity distribution, influencing migration patterns (Bleha & Buček, 2023), where housing is a dominant motivator alongside distance, education, and population (Lichner et al., 2024), and migration significantly enhances economic status, exceeding the impact of additional education (Ward, 2020), with housing and family motives remaining central, particularly evident in concentration in affluent suburban areas (Baláž et al., 2023). Slovakia‘s economic reforms and EU accession significantly altered migration, driving urbanization and suburbanization around economic hubs (Bezák, 2000; Bezák, 2014; Matlovič & Sedláková, 2004), mirroring Central European trends where employment, infrastructure, and quality of life drive migration to metropolitan areas, exacerbating regional economic disparities (Brandén, 2013; Piper, 2005; Shauman, 2010), with development demonstrating intensified concentration and decentralization, influenced by economic crises (Novotný, 2016). Slovakia‘s post-socialist development fostered uneven growth and foreign capital dependency, particularly along the Bratislava-Žilina automotive corridor (Jacobs, 2017), with neoliberal reforms, driven by policy networks, reducing government involvement and increasing socioeconomic risks (Fisher et al., 2007), and intra- and trans-generational migrant networks shaping labor migration, as the Bratislava Region emerged as a key automotive production hub through government-foreign automaker collaboration (Jacobs, 2013).

Urbanization, Suburbanization, and Spatial Transformations

Beyond economic factors, migration in Slovakia catalyzes spatial transformation through suburbanization and gentrification, expanding functional urban regions (Bezák, 1991a, 1991b; Šveda & Šuška, 2019; Kryczka et al., 2025) with suburban areas experiencing consistent net migration gains (Bezák, 2008), aligning with European trends, where affordable housing and improved transport attract residents to suburbs (Brandén & Haandrikman, 2019; Farkas & Klobučník, 2021), driving socio-cultural and spatial restructuring (Bošelová, 2019; Balizs & Bajmócy, 2019), contributing to disintegrating spatial equity, creating urban-rural divergence and inequality, with knowledge-based economies contrasting with traditional industrial policies (Ondoš et al., 2024).

Contrasting suburbanization, urban shrinkage, prevalent in post-industrial and mining cities, involves population decline due to out-migration and economic decline (Buček & Bleha, 2013; Buček et al., 2022) leading to socioeconomic challenges like reduced municipal resources, declining services, and increased inequalities, exacerbating regional disparities (Buček & Bleha, 2013) and shrinkage (Simeonova & Milkova, 2020; Wiechmann & Wolff, 2013). Economic growth is possible despite population decline, with modern industries (Bartholomae et al., 2017). Urban shrinkage can be driven by reindustrialization, restructuring, and agglomeration (Li & Mykhnenko, 2018), influenced by industrial diversity (Wang et al., 2020). Many European cities shrink due to economic and demographic factors (Wolff & Wiechmann, 2018) and economic and social dependencies, along with urban sprawl (Reckien & Martinez-Fernandez, 2011), necessitating a process-oriented policy approach (Haase et al., 2014) and labor participation reflecting migration (Hartt, 2016). The diverse nature of urban shrinkage demands to address its causes and consequences (Haase et al., 2016).

Migration Selectivity and Human Capital Mobility

Migration selectivity, influenced by age, education, and skill, is a key factor, with age-dependent patterns linked to life transitions (Baláž et al., 2023) and younger, educated individuals migrating to urban centres for better opportunities (Šprocha, 2011a, 2011b, 2011c; Cooke, 2003), contributing to „brain drain" from peripheral regions (Šprocha et al., 2017). While European labour mobility is lower than in the US, with greater spatial unemployment and income variations (Dorn & Zweimüller, 2021), migration can have moderate short-term labour market impacts with potential long-term crowding-out (Kaczmarczyk & Okólski, 2008) and may lead to deteriorating working conditions and wages in some sectors (Refslund, 2016), impacting welfare, benefits for high-skilled non-EU immigrants and potential income drops for low-skilled workers (Cardoso, 2020). Demographic and economic factors necessitate integration efforts (Bite et al., 2020). While highly educated migrants positively impact innovation (Fassio et al., 2019), Slovak migration exhibits selectivity, deepening the urban-rural divide in education and economic opportunities, resulting in sociodemographic divergence and human capital disparities (Brandén, 2013; Čermák, 2005), also impacting family dynamics and gender roles, with higher mobility of younger women to urban areas for careers (Piper, 2005), mirroring Western European trends (Shauman, 2010; Feijten & Mulder, 2010). Women may experience earnings declines when migrating for family reasons (Geist & McManus, 2012), and education positively influences migration more so for women over time (Williams, 2009). Local work and family ties reduce family migration likelihood, with men's work ties having a greater influence (Mulder & Malmberg, 2014).

Peripheralization and Socioeconomic Polarization

Slovakia's migration impact is spatially uneven, with intensified polarization (Bezák, 2006; Bleha & Buček, 2023), as western regions, especially Bratislava, concentrate migration benefits, while eastern regions face out-migration and stagnation. Migration efficiency highlights Bratislava's attractiveness and eastern regions' out-migration (Bezák, 2008), with migration balance confirming western Slovakia's benefits, particularly in the Bratislava metropolitan area. This polarization, with a strong Bratislava-rest divide post-1989 (Baláž, 2007), is driven by factors like unemployment, urbanization, education, and foreign investment, while eastern Slovakia attracts Ukrainian migrants (Koroutchev & Novotný, 2020). Socio-spatial polarization has led to stagnation and marginalization in some areas (Máliková & Klobučník, 2017).

Migration in post-socialist countries is shaped by economic, social, and political factors, especially economic factors intertwined with education and EU integration. Peripheralization, influenced by migration, socio-spatial change, and governance, shapes regional development (Bezák, 2014; Bleha & Buček, 2023), and policy efforts showing limited impact on inequalities. This highlights regional economic inequality's role in migration, with socio-spatial transformations and inequalities in urban fringes requiring specialized governance (de Vidovich, 2021). Emigration is driven by economic, labour market, and aspirational factors (Fihel & Kaczmarczyk, 2023). Post-socialist transformations and EU integration shape labor migration (Stan & Erne, 2014), and cities experienced population loss due to emigration and suburbanization (Ott, 2001). Migration, marked by age and education selectivity, regional economic disparities, and housing or family motives, leads to east-west polarization and metropolitan concentration. Migration selectivity intensifies regional polarization (Williams & Baláž, 2001), with economic and infrastructure advantages driving migration west and eastern regions facing losses, moderated by distance, economic disparities, and housing markets (Lichner et al., 2024). Roma migration is driven by housing, family, and health (Slavíková & Šprocha, 2023). Post-socialist migration contributes to population and human capital decline, especially in rural areas (Novotný, 2019), and interregional migration is influenced by unemployment, real wages, and population density, with developed regions having higher activity (Janotka & Gazda, 2012).

3 MATERIAL AND METHODS

This study quantitatively analyzes district-level migration and socioeconomic indicators in Slovakia from 2002 to 2022. Migration data, including the Gross Migration Balance Rate (GMBR), Migration Efficiency Index (MEI), and Attraction Efficiency Index (AEI), were sourced from the Statistical Office of the Slovak Republic (2025). These data were combined with socioeconomic variables (population density, age structure, unemployment, GDP per capita) from the same source, and housing price data from the Národná banka Slovenska (2025), to assess the relationship between migration, demographics, and economic conditions across districts. Migration data, referring to in-migrants to and out-migrants from permanent residence, includes individuals, irrespective of citizenship, who changed their permanent residence either within the Slovak Republic (internal migration, involving changes of municipality or municipal district in Bratislava and Košice) or across national borders (international migration).

Migration patterns were quantified using the following indicators: (1) GMBR, net migration per 1,000 inhabitants, for standardized regional comparisons; (2) MEI, the ratio of net migration to total migration flows, ranging from -100% to +100%, where positive values indicate net migration gains and negative values indicate net migration losses; and (3) AEI, the percentage of net migration relative to in-migration, capturing a district's retention capacity. Spatial panel regression models were employed to analyze temporal trends and spatial dependencies. A Spatial Autoregressive Model with Autoregressive Disturbances (SARAR) was employed, accounting for spatial lag (λ) and spatial error (ρ) effects. Hausman tests indicated a panel fixed effects structure. The regression specification is:

$$y = \lambda(I_T \otimes W_N)\gamma + X\beta + u \quad (1)$$

$$u = \lambda(l_T \otimes I_N)\mu + \varepsilon \quad (2)$$

$$\varepsilon = \rho(I_T \otimes W_N)\varepsilon + \nu \quad (3)$$

The dependent variable (y) represents migration outcomes: GMBR, MEI, and AEI, used in alternative specifications. Explanatory variables (X) include population density, GDP per capita, the unemployment rate, residential property values, and the proportion of the population aged 25–34. The spatial weight matrix (WN) models spatial interactions, based on the assumption that neighbouring districts influence migration trends. The term u accounts for unobserved influences. Parameters λ and ρ quantify spatial autocorrelation: λ measures the influence of migration in neighbouring districts, and ρ captures spatial autocorrelation in the error term. The spatial weight matrix is constructed based on contiguity, where directly adjacent districts are considered neighbours. The final dataset comprises 79 districts over 21 years.

While GDP per capita is typically applied to broader regional analyses to capture wider economic trends, its inclusion at the district level accounts for the influence of broader economic disparities on local migration, as regional economic differences can indirectly shape district attractiveness. The use of NUTS3 level data for some district-level variables, necessitated by availability, introduces a degree of generalization, particularly given the prevalence of short-distance migration within functional urban areas. However, we contend that these variables still capture important regional contexts influencing district-level migration. Our approach, incorporating spatial autocorrelation, partly mitigates these scaling issues by modelling how neighbouring districts influence each other. Despite these limitations, we maintain that the chosen variables offer valuable insights into the multi-scalar factors of migration, and their omission would risk introducing bias by excluding relevant information.

4 RESULTS

Regional Economic Divergence and Migration Patterns

The temporal dynamics of mean unemployment and residential property prices reveal distinct economic periods influencing migration. From 2002 to 2008, declining unemployment (from 18% to 9%) and rising property prices (peaking above 1000 EUR/m²) suggest economic expansion, fostering urban migration. The 2008 – 2009 financial crisis saw unemployment surge to 14% and property prices temporarily decline. From 2010 to 2016, a prolonged recovery occurred, with fluctuating unemployment and stagnant property prices. The period from 2017 to 2022 saw renewed growth, with unemployment near 5% in 2019 and property prices peaking above 2000 EUR/m² in 2022. The Covid-19 pandemic caused temporary rise in unemployment, but property prices continued to increase. These economic periods, defined by unemployment and property price trends, significantly influenced migration, with growth periods driving urban migration and downturns potentially increasing out-migration or shifting migration destinations.

Tab. 1 shows regional unemployment rates and residential property prices across pre-crisis, crisis/recovery, and post-recovery periods. In the pre-crisis period, Bratislava Region exhibited the lowest unemployment rates and highest residential property prices, indicating robust economy, while Eastern Slovakia faced the highest unemployment rates and lowest residential property prices, highlighting its economic disadvantage. Western and Central Slovakia showed intermediate values. During the crisis/recovery period, unemployment rates increased across all regions, with the most significant rise observed in Eastern Slovakia. Residential property prices showed moderate increases, particularly in the Bratislava Region. In the post-recovery period, unemployment rates declined substantially, most notably in Western Slovakia. Residential property prices continued to rise, with the Bratislava Region leading. These regional variations highlight persistent economic polarization, with Bratislava Region and Western Slovakia experiencing greater prosperity, while Eastern Slovakia lags.

Tab. 2 shows regional migration patterns across the three economic periods, illustrating increasing west-east polarization. In the pre-crisis period, the Bratislava Region was the primary attractor, reflecting its strong economic growth and low unemployment

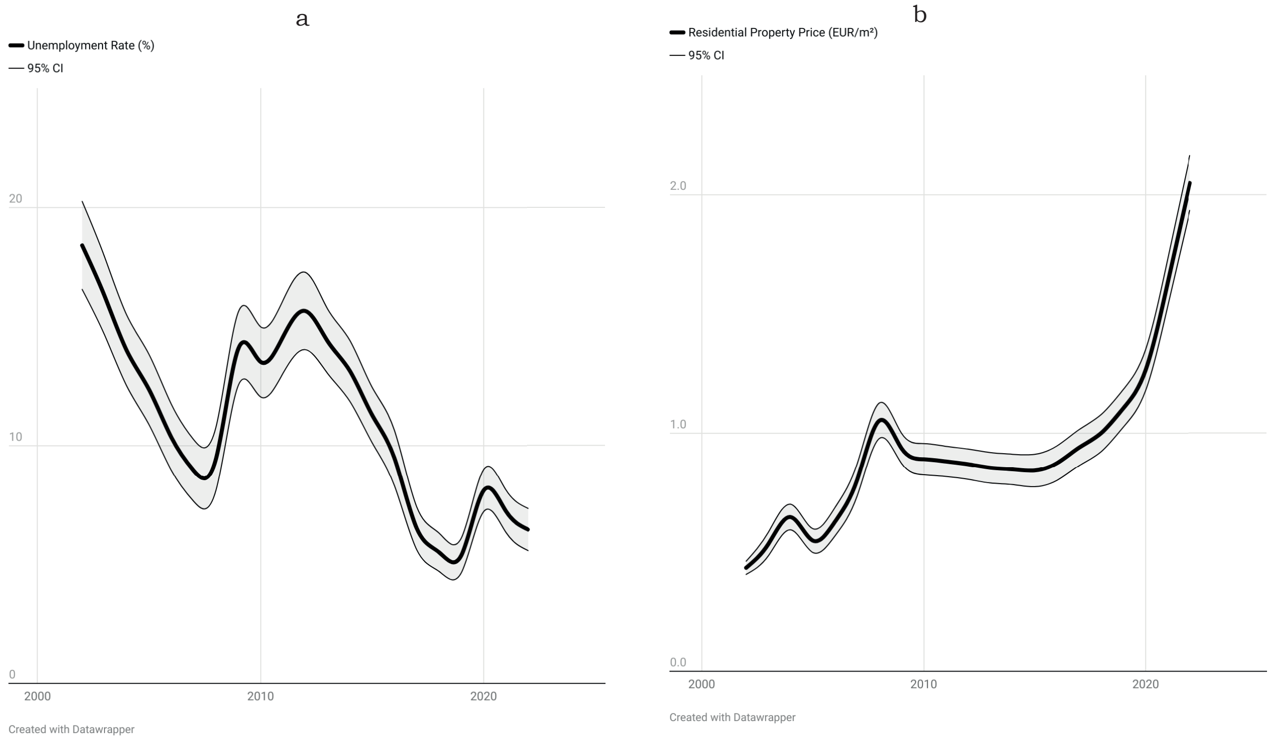


Fig. 1. Temporal trends in unemployment rates and residential property prices in Slovakia (2002–2022). This figure illustrates the evolution of (a) the national average unemployment rate (%) and (b) average residential property prices (EUR/m²), highlighting key economic phases that influenced migration patterns. Sources: Statistical Office of the SR (2025), Národná banka Slovenska (2025).

Tab. 1. Regional unemployment rates and residential property prices in Slovakia (2002–2022). This table compares key economic indicators across four major regions, showing persistent disparities between western and eastern Slovakia. Sources: Statistical Office of the SR (2025), Národná banka Slovenska (2025).

	Unemployment Rate		
	2002 – 2008	2009 – 2015	2016 – 2022
Bratislava Region	3.2	5.5	3.7
Western Slovakia	9.2	10.0	4.0
Central Slovakia	15.3	16.0	7.5
Eastern Slovakia	17.0	18.0	10.3
	Residential Property Price		
	2002 – 2008	2009 – 2015	2016 – 2022
Bratislava Region	1.3	1.7	2.3
Western Slovakia	0.6	0.7	1.0
Central Slovakia	0.6	0.8	1.1
Eastern Slovakia	0.6	0.9	1.3

Spatial Interdependencies in Migration

Tab. 2**.** Regional migration patterns in Slovakia (2002–2022). The table highlights the migration consequences of economic trends, revealing increasing polarization between Western and Eastern regions. Source: Statistical Office of the SR (2025).

	GMBR		
	2002 – 2008	2009 – 2015	2016 – 2022
Bratislava Region	5.2	8.9	10.1
Western Slovakia	1.3	0.1	-0.2
Central Slovakia	-0.1	-0.9	-1.3
Eastern Slovakia	-1.4	-1.5	-1.8
	MEI		
	2002 – 2008	2009 – 2015	2016 – 2022
Bratislava Region	14.5	20.3	19.7
Western Slovakia	7.7	0.5	-1.8
Central Slovakia	-2.1	-7.1	-9.0
Eastern Slovakia	-8.6	-10.0	-11.4
	AEI		
	2002 – 2008	2009 – 2015	2016 – 2022
Bratislava Region	18.6	28.0	29.3
Western Slovakia	11.4	-2.6	-7.9
Central Slovakia	-7.2	-18.6	-23.5
Eastern Slovakia	-23.1	-27.5	-32.6

Spatial Interdependencies in Migration

Tab. 3. Summary statistics and definitions of migration indices and key socioeconomic variables. This table provides an overview of the dependent and explanatory variables used in the study, detailing their expected influence on migration dynamics. Sources: Statistical Office of the SR (2025), Národná banka Slovenska (2025).

Variable	Description	Min.	Max	Mean
GMBR	Net migration rate per 1,000 residents	-13.1	37.1	0.2
MEI	Ratio of net migration to total migration flows	-48.5	63.0	-2.4
AEI	Ratio of net migration to total in-migration	-188.3	77.3	-10.8
Population Density	Number of inhabitants per square kilometer (in thousands)	0.0	4.9	0.3
GDP per Capita	Gross Domestic Product per person, adjusted for purchasing power parity	6.6	53.9	17.9
Unemployment Rate	Percentage of the economically active population that is unemployed	1.5	37.2	11.2
Residential Property Prices	Average residential property price per square meter (in thousands of Euros)	0.4	3.4	0.9
Population Aged 25–34		11.5	24.9	15.7

rates. Western Slovakia also experienced net in-migration, though with smaller gains. Central and Eastern Slovakia experienced net out-migration, with Eastern Slovakia having the largest net losses. During the crisis/recovery period, the Bratislava Region continued to attract migrants, further increasing its migration efficiency. Western Slovakia's net migration balance remained slightly positive, but its MEI and AEI decreased. Central and Eastern Slovakia saw increased net out-migration, with more negative MEI and AEI values. In the post-recovery period, the Bratislava Region remained the dominant attractor. Western Slovakia's net migration balance turned negative, with further decreases in its MEI and AEI. Central and Eastern Slovakia continued to experience substantial net out-migration, deepening spatial polarization.

Spatial Interdependencies in Migration

Tab. 3 defines dependent and explanatory variables and their expected influence on migration. The Gross Migration Balance Rate (GMBR) is expected to be positive in dynamic regions, indicating net in-migration, and negative in stagnating ones, reflecting net out-migration driven by economic push/pull. The Migration Efficiency Index (MEI) is expected to be highest where in-migration significantly exceeds out-migration, indicating structural advantages and attractiveness, and lowest where outflows dominate, indicating structural disadvantages. The Attraction Efficiency Index (AEI) is expected to be high in accessible districts that effectively attract and retain migrants and low in less accessible or less attractive regions.

Regarding the explanatory variables' influence: GDP per capita is expected to positively affect net in-migration, indicating attraction to more prosperous regions, although spatial effects might lead to displacement. The impact of the unemployment rate is complex: high unemployment is expected to drive out-migration from affected regions but may also increase short-distance migration within or to neighbouring areas, resulting in an ambiguous overall effect on spatial efficiency. High residential property prices are expected to constrain net in-migration due to affordability issues, although they may also drive suburbanization towards areas with lower housing costs. The effect of population density is ambiguous, potentially signalling the attraction of urban agglomerations or the repulsion of congested areas. Finally, a higher proportion of the population aged 25–34 is expected to be strongly correlated with migration, with urban centres typically benefiting from inflows of this mobile age group and rural areas often experiencing youth out-migration.

Fig. 2 shows the spatial distribution of migration indices, revealing regional disparities. As expected, Bratislava and its suburbs exhibit the highest positive migration balances and efficiency, confirming their role as attractors due to economic opportunities, suburban expansion, and well-developed infrastructure; this supports the hypothesis that wealthier regions act as pull factors. Conversely, eastern and some central districts display negative migration balances and efficiency, indicating out-migration from economically weaker areas. Attraction Efficiency Index (AEI) patterns suggest urban hubs possess migration stability but lack Bratislava's strong net positive migration, implying a weaker centripetal force compared to the capital. Medium-sized urban districts show moderately positive Migration Efficiency Index (MEI) values, possibly reflecting growing industries and connectivity. Overall, these spatial patterns suggest migration reinforces regional disparities, emphasizing the decisive role of economic development, infrastructure quality, and regional accessibility in shaping Slovak migration dynamics.

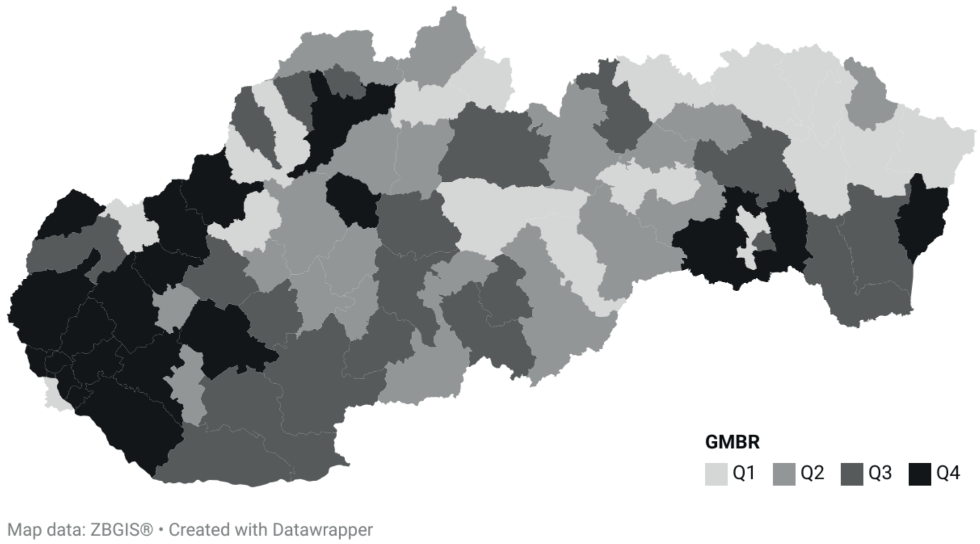
Tab. 4's specification tests confirmed the robustness and validity of the spatial econometric model. Lagrange Multiplier tests indicated statistically significant spatial dependence. The LM1 test detected spatial lag dependence, demonstrating the influence of neighboring districts on migration patterns. The LM2 test identified spatial error dependence, suggesting the presence of spatially correlated errors. Conditional LM tests further validated these findings: the CLMμ test specifically confirmed spatial error dependence, and the CLMλ test supported the presence of spatial lag effects. A Hausman test strongly favored the fixed effects model specification, confirming that district-specific characteristics exert a significant influence on migration.

Tab. 5 presents estimated coefficients from the spatial panel fixed effects SARAR model. Significant λ and ρ values indicate strong spatial dependence in migration patterns. The negative λ coefficient suggests a negative spatial autocorrelation in neighbouring

Tab. 4. Lagrange Multiplier and Hausman test results confirming spatial dependence. Statistical significance: *p<0.10, **p<0.05, ***p<0.01. These diagnostic tests validate the appropriateness of employing spatial econometric models, indicating the necessity of controlling for spatial autocorrelation in the data.

	Lagrange Multiplier Tests		
	GMBR	MEI	AEI
LMH	7,027.641***	6,526.645***	5,758.682***
LM1	83.690***	79.835***	75.026***
LM2	4.860***	12.370***	11.390***
	Conditional LM Tests		
	GMBR	MEI	AEI
CLMλ	7.751***	5.970***	4.613***
CLMμ	87.109***	79.674***	74.883***
	Hausman Tests		
	GMBR	MEI	AEI
Lag	45.597***	200.205***	95.709***
Error	114.700***	37.625***	51.845***
Spatial Autoregressive Model (SARAR)	11.039*	89.705***	56.905***

a



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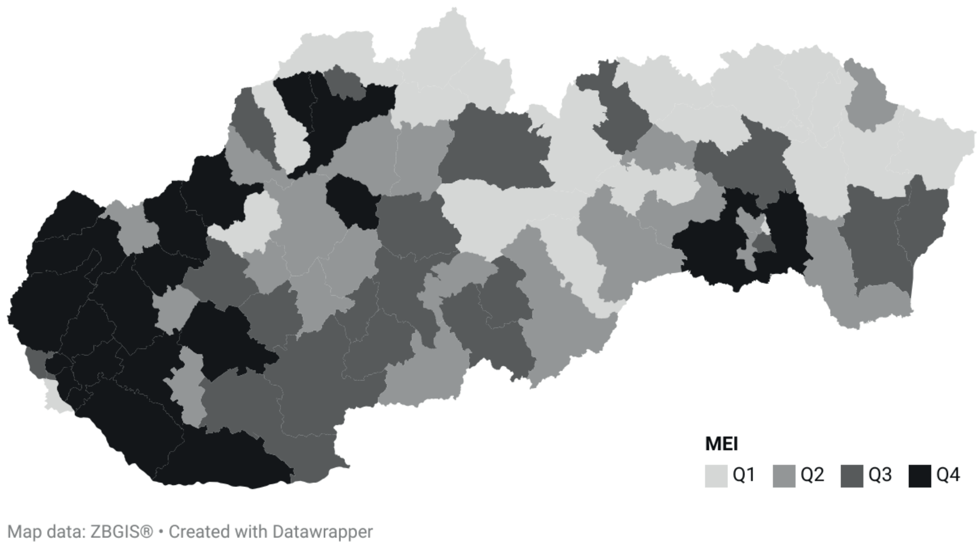

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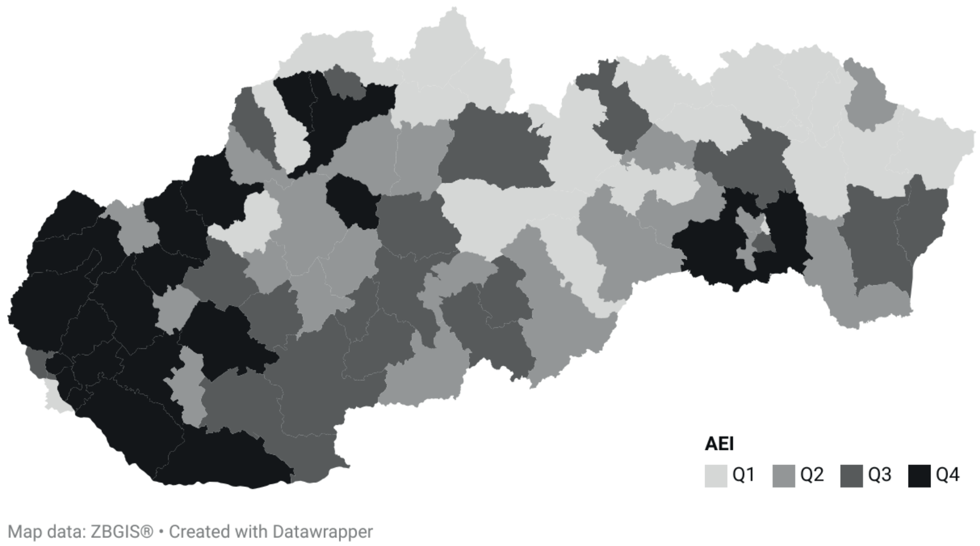

Fig. 2. Spatial distribution of migration indices across districts (2002–2022). Maps illustrate the regional variations in (**a**) Gross Migration Balance Rate (GMBR), (**b**) Migration Efficiency Index (MEI), (**c**) Attraction Efficiency Index (AEI). Sources: Statistical Office of the SR (2025), GKÚ Bratislava (2025).

districts' net migration, possibly reflecting competitive dynamics. The positive ρ coefficient confirms spatial autocorrelation in the error term, indicating the influence of unobserved spatial factors on migration. GDP per capita exerts a positive effect on the Gross Migration Balance Rate (GMBR), suggesting that regional prosperity contributes to net migration gains, but does not significantly influence migration efficiency (MEI) or attraction efficiency (AEI). The unemployment rate exhibits a positive effect across all models, implying that higher unemployment rates are associated with increased migration flows, likely driven by labour mobility. Residential property prices demonstrate a negative impact on the GMBR, suggesting that high housing costs deter in-migration. Finally, the proportion of the population aged 25–34 shows a negative relationship with all migration indices, indicating net losses in districts with a larger share of young adults, potentially due to youth out-migration.

Tab. 6 decomposes the effects of explanatory variables into direct, indirect, and total effects, thereby accounting for the spatial structure of the data. GDP per capita exerts a positive direct effect on the Gross Migration Balance Rate (GMBR), indicating that wealthier districts attract migrants directly, but also exhibits a significant negative indirect effect, suggesting that these wealthy districts may draw migrants away from neighbouring areas, reinforcing spatial polarization. The unemployment rate demonstrates a strong positive direct effect, implying that higher unemployment rates within a district increase out-migration from that district. However, the negative indirect effect suggests reduced migration efficiency in surrounding districts of high-unemployment regions, reflecting broader regional economic stagnation. Residential property prices directly reduce both the GMBR and migration efficiency, indicating that high housing costs within a district deter net in-migration and reduce overall migration efficiency. Conversely, the positive indirect effects imply that high housing costs in one district may push migration into adjacent areas with more affordable housing. Finally, the proportion of the population aged 25–34 maintains its strong negative influence across migration indices, with significant negative direct and indirect effects, reinforcing youth out-migration and associated regional demographic imbalances.

Tab. 5. Estimated coefficients from the spatial panel fixed effects SARAR model for migration indices. Standard errors in parentheses. Statistical significance: *p<0.10, **p<0.05, ***p<0.01. This table presents the estimated relationships between migration outcomes and explanatory variables, while accounting for spatial dependencies.

	GMBR	MEI	AEI
λ (lambda)	-0.841 (0.052)***	-0.645 (0.068)***	-0.610 (0.073)***
ρ (rho)	0.759 (0.024)***	0.657 (0.037)***	0.608 (0.044)***
Population Density	-1.930 (1.455)	-8.026 (6.120)	-25.039 (14.526)*
GDP per Capita	0.275 (0.043)***	-0.067 (0.143)	-0.424 (0.308)
Unemployment Rate	0.098 (0.025)***	0.436 (0.091)***	1.136 (0.205)***
Residential Property Prices	-2.192 (0.525)***	-2.845 (1.725)*	-3.521 (3.706)
Population Aged 25–34	-0.303 (0.046)***	-0.580 (0.189)***	-1.563 (0.444)***

Tab. 6. Direct, indirect, and total effects of explanatory variables in the spatial model. Standard errors in parentheses. Statistical significance: *p<0.10, **p<0.05, ***p<0.01. This table quantifies spatial spillover effects on migration dynamics, illustrating how regional conditions influence migration patterns in neighboring districts.

	GMBR		
	Direct	Indirect	Total
Population Density	-2.204 (1.671)	1.162 (0.934)	-1.042 (0.792)
GDP per Capita	0.314 (0.054)***	-0.165 (0.035)***	0.148 (0.031)***
Unemployment Rate	0.112 (0.028)***	-0.059 (0.018)***	0.053 (0.015)***
Residential Property Prices	-2.503 (0.571)***	1.320 (0.338)***	-1.184 (0.289)***
Population Aged 25–34	-0.346 (0.050)***	0.182 (0.039)***	-0.164 (0.031)***
	MEI		
	Direct	Indirect	Total
Population Density	-8.672 (6.798)	3.794 (2.966)	-4.878 (3.867)
GDP per Capita	-0.073 (0.145)	0.032 (0.063)	-0.041 (0.082)
Unemployment Rate	0.471 (0.101)***	-0.206 (0.049)***	0.265 (0.057)***
Residential Property Prices	-3.074 (1.728)*	1.345 (0.742)*	-1.729 (1.001)*
Population Aged 25–34	-0.627 (0.216)***	0.274 (0.099)***	-0.353 (0.121)***
	AEI		
	Direct	Indirect	Total
Population Density	-26.832 (16.381)	11.275 (6.908)	-15.557 (9.574)
GDP per Capita	-0.455 (0.323	0.191 (0.137)	-0.264 (0.188)
Unemployment Rate	1.217 (0.212)***	-0.511 (0.101)***	0.706 (0.127)***
Residential Property Prices	-3.773 (4.016)	1.586 (1.718)	-2.188 (2.317)
Population Aged 25–34	-1.675 (0.496)***	0.704 (0.218)***	-0.971 (0.294)***

5 DISCUSSION

The findings of this study strongly support the presence of spatial migration polarization in Slovakia, aligning with broader patterns of post-socialist demographic restructuring and existing regional economic disparities. Migration dynamics are shown to be significantly influenced by economic factors, infrastructure development, and urbanization processes, which collectively reinforce the observed west-east inequalities. Bratislava consistently emerges as the dominant attractor of migrants, while eastern districts experience sustained population losses due to out-migration. These results validate established theories of economic agglomeration and observed migration patterns (Rees et al., 2017; Rowe et al., 2019) and underscore the importance of spatial effects in understanding migration efficiency (Bell et al., 2015). Bratislava's persistent high migration efficiency, particularly in its suburban areas, corroborates previous studies on suburbanization and the expansion of urban regions (Bezák, 2000; Kakaš et al., 2017). The increasing Attraction Efficiency Index (AEI) in urbanized areas suggests urban sprawl driven by infrastructure development, property values, and labour market concentration, which aligns with findings emphasizing housing and family motives in migration (Baláž et al., 2023). This pattern mirrors the trend of suburban growth outpacing urban expansion observed in other countries (Brandén & Haandrikman, 2019). However, the negative indirect effects of rising property prices, as identified in our spatial model, suggest the potential displacement of lower-income population groups (Novotný et al., 2023).

Conversely, the persistent out-migration observed in eastern Slovakia aligns with the concept of labour market-driven migration selectivity (Hejduková & Kureková, 2020). The negative Gross Migration Balance Rate (GMBR) in these districts indicates that economic stagnation and limited infrastructure act as significant push factors, driving population decline. This finding reinforces previous studies on spatial polarization in Slovakia (Bezák, 2014; Matlovič et al., 2018) and underscores the primacy of economic opportunity as a key factor of migration flows (Lichner et al., 2024). The negative Migration Efficiency Index (MEI) in eastern Slovakia suggests a structural demographic decline, a pattern also observed in other post-socialist regions (Musil, 1993; Sýkora, 2009). Furthermore, migration selectivity, as evidenced in our results, reinforces existing spatial inequalities, with younger individuals migrating towards more economically dynamic regions, consequently leaving older populations concentrated in stagnating areas. This trend is consistent with broader studies on human capital mobility (Dorn & Zweimüller, 2021) and the phenomenon of brain drain from peripheral regions (Bleha & Buček, 2023). The negative association identified in our model between migration efficiency and the proportion of young adults in peripheral districts highlights how this selective migration contributes to demographic ageing, thereby exacerbating existing economic challenges in these areas. Similar depopulation trends have been documented elsewhere in Europe, often leading to economic decline and reduction in available public services (Haase et al., 2014). Consequently, regional disparities in Slovakia appear to be increasingly self-reinforcing, with high-skilled individuals concentrating in prosperous regions and peripheral areas facing sustained human capital losses (Fihel & Kaczmarczyk, 2023).

The econometric results robustly confirm the presence of spatial interdependencies in migration patterns across Slovakia, revealing statistically significant spillover effects. Specifically, the spatial autoregressive component of the model demonstrates that migration trends in a given district are indeed influenced by migration patterns in adjacent regions, particularly evident in suburban areas. The negative spatial lag coefficient observed for the Migration Efficiency Index (MEI) suggests a degree of competitive migration, wherein net migration gains in one district may be associated with net losses in neighbouring districts, a finding that aligns with studies of intra-metropolitan migration dynamics (Ondoš et al., 2024). The positive spatial autocorrelation in the error term confirms the influence of unobserved structural factors, such as regional policies or amenities, that contribute to migration variations across space, underscoring the importance of considering spatial externalities in regional development analysis (Bartholomae et al., 2017). While GDP per capita and the unemployment rate exhibit statistically significant effects on the Gross Migration Balance Rate (GMBR), their impact on migration efficiency indices (MEI and AEI) is more nuanced. High unemployment rates are associated with migration inefficiencies, where population loss in some areas is not effectively balanced by gains in others, corroborating the idea that economic distress can create fragmented and less efficient migration flows (Ward, 2020). The mixed effects observed for GDP per capita suggest that while economic growth attract migrants, it does not always guarantee long-term retention, particularly in the presence of high housing costs (Podolák, 1995; Baláž, 2007). Ultimately, these findings emphasize that migration patterns must be understood within a broader context that includes social networks, housing market dynamics, and the impact of policy interventions, rather than solely through the lens of economic incentives (Bahna, 2013).

6 CONCLUSION

This study analyzed Slovak migration from 2002 to 2022, revealing significant spatial and socioeconomic patterns. Spatial econometric models demonstrated varying migration efficiency and attraction across districts, reinforcing regional inequalities. Bratislava and its metropolitan area continuously gained population through economic opportunities and suburban expansion, while eastern Slovakia experienced persistent out-migration due to economic stagnation and infrastructure limitations. Migration selectivity, particularly by age and education, significantly contributes to regional disparities. Increasing suburbanization around Bratislava highlights the importance of spatial externalities in urban planning. Migration is influenced by infrastructure, demographics, and regional policies, not just economic incentives. These findings contribute to post-socialist migration discussions, offering empirical evidence on economic restructuring's long-term regional effects. While focused on Slovakia, these findings have implications for other Central and Eastern European countries experiencing similar polarization. Future research should examine migration policies, labour market integration, and infrastructure development to understand migration's long-term impact on regional economies.

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