Podnebne spremembe in dejavniki notranjih migracij v Srbiji

Climate Change and Internal Migration Drivers in Serbia

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IZVLEČEK

V zadnjih desetletjih okoljske in podnebne spremembe vse močneje vplivajo na mobilnost in migracije ljudi, ki jih še dodatno krepijo gospodarske krize, socialne razlike in nedavni geopolitični konflikti. Globlje razumevanje povezav med migracijami, podnebnimi spremembami in socialno-ekonomsko dinamiko je bistvenega pomena za oblikovanje in izvajanje učinkovitih politik trajnostnega razvoja. V prispevku je predstavljena študija primera na ravni okrožja v Republiki Srbiji, ki preučuje vpliv več strukturnih in kontekstualnih dejavnikov notranjega izseljevanja v obdobju 2000–2024. Opaženi so bili vplivi štirih dejavnikov na stopnjo izseljevanja: trga dela, podnebnih dejavnikov, turizma in kmetijstva. Rezultati kažejo, da se v tej študiji, specifični za posamezno državo, izseljevanje povečuje z močnejšo dinamiko trga dela in večjo turistično aktivnostjo. Hkrati so ugodnejše podnebne razmere in večji delež kmetijskih zemljišč v uporabi povezani z nižjimi stopnjami izseljevanja po okrožjih. Predlagani model z zadovoljivim prilagajanjem in napovedno močjo ponuja vpogled in longitudinalni pregled nad tem, kako ekonomski in okoljski dejavniki vplivajo na stopnjo izseljevanja v državi v razvoju.

ABSTRACT

Over the last decades, environmental and climate change have had increasingly profound implications for human mobility and migration, further intensified by economic crises, social disparities, and recent geopolitical conflicts. A deeper understanding of the interconnections between migration, climate change, and socioeconomic dynamics is essential for designing and implementing effective, sustainable development policies. This study presents a district-level case study of the Republic of Serbia, examining the impact of several structural and contextual drivers of internal outmigration over the period 2000–2024. The impacts of four factors on the Emigration rate have been observed: Labour market, Climate factors, Tourism, and Agriculture. The results indicate that in this country-specific study, emigration increases with stronger labour market dynamics and higher tourist activity. At the same time, more favourable climate conditions and a greater share of agricultural land in use are associated with lower emigration rates across districts. The proposed model, with a satisfactory fit and predictive power, provides insights and a longitudinal overview of how economic and environmental factors affect the emigration rate in a developing country.

KLJUČNE BESEDE

stopnja izseljevanja, podnebne migracije, okolje, konceptualni model, Srbija

KEY WORDS

emigration rate, climigration, environment, conceptual model, Serbia

1 Introduction

Population dynamics, encompassing fertility, mortality, and migration, are governed by a complex interplay of factors that extend beyond purely demographic determinants. As contemporary global challenges continue to evolve, an expanding body of scholarship has sought to disentangle the multifaceted drivers underlying these demographic processes. In recent years, researchers have focused on how specific economic, social, or environmental factors affect the components of population dynamics. For example, it was analysed how cold spells impact mortality (Marinković and Potić, 2025) and how high temperatures impact fertility (Conte Keivabu et al., 2025). Even a completely new term was coined to explore the effects of climate change on migration, named climigration (Matthews and Potts, 2018).

In the present study, we focus on one component of population dynamics, migration, and try to untangle the drivers of emigration in emerging countries. So far, extensive literature has been published on the drivers of migration. The first notable paper is the comprehensive review conducted by Piguet et al. (2018) on climate factors which trigger migration. The authors have identified five categories of climatic hazards: droughts, floods, hurricanes, sea level rise, and rainfall. A more recent systematic review identified nineteen climate-related causes of migration, merged into eight categories (Ghosh and Orchiston, 2022). The growing number of climatic hazard categories indicates that researchers are recognising a broader, more complex set of climate-related pressures that influence migration. When it comes to the economic explanation of migration, numerous theories and models have been developed since the 1950s (Hagen-Zanker, 2008). Tourism has also recently been explored as an important factor in migration (Sarı and Meydan Uygur, 2024). The UNWTO even differentiates tourism-led migration (TLM) and migration-led tourism (MLT) (UNWTO, 2009). Contemporary research shows that migration in emerging contexts cannot be understood without acknowledging the combined effects of climate variability, economic conditions, and tourism dynamics.

In this research, we focused on the aforementioned impacts in the Republic of Serbia, an emerging economy profoundly shaped by migration. Serbia's emigration patterns reflect a long tradition of mobility and migration, driven by specific economic, political, and geographical contexts (Predojević-Despić and Penev, 2016). Serbia has significant and persistent regional disparities with internal migrations, as outlined in previous research (González et al., 2024; Molnar and Jandric, 2019). Estimates indicate that the Republic of Serbia is warming more rapidly than the global average. While the global average temperature has increased by 1.1°C, Serbia has already reached a 1.8°C increase, with the summer increase as high as 2.6°C. Since 2000, the Republic of Serbia has also experienced several significant extreme climate and weather events that have caused substantial material and financial losses, as well as loss of human life (Government of the Republic of Serbia, 2023). Given the economic situation, Serbia has been significantly affected by the previous and current global economic challenges. The consequences are visible in the GDP decline, rising unemployment, currency depreciation, reduced investments, and general uncertainty among citizens and businesses (Rajević, 2025). Within this context, the underlying factors driving migration emerge (Gara and Fetai, 2024).

To unravel and understand the factors and drivers of migration in the Republic of Serbia, we propose a conceptual model. To capture the multifaceted impacts on migration, we propose a model that encompasses four factors: *Labour market*, *Climate factors*, *Tourism*, and *Agriculture*. It is believed that the proposed model will provide insights into the causal mechanisms that impact internal emigration in

Serbia. The model verification was conducted on NUTS 3 district-level data from 2000 to 2024 using structural equation modelling (SEM) and the cluster-robust Huber–White estimator.

2 Theoretical background

Forced migration due to threats to life and property caused by climate change and environmental hazards is a specific form of migration. This form of migration can be assisted or planned by government agencies, and unplanned (IOM, 2019). Climate-induced migration has been examined across both macro- and micro-levels (Freihardt, 2025; Hoffmann et al., 2020). Besides the different levels at which climate-induced migration can be researched, it is important to account for the fact that different types of environmental hazards affect migration behaviour differently (Koubi et al., 2016). The new Groundswell report (Clement et al., 2021, pp. xxii) states that "*without early and concerted climate and development action, as many as 216 million people could move within their own countries due to slow-onset climate change impacts by 2050*." Their projections foresee migration from areas with lower water availability and crop productivity, as well as from areas affected by sea-level rise and storm surges. Matthews and Potts (2018) argue that climigration does not represent a future challenge but rather constitutes an urgent contemporary phenomenon and a critical endpoint within the spectrum of climate-adaptation responses.

Economic models by Todaro (1969) and Harris and Todaro (1970) were among the first models to explain migrations through salary differentials and labour market tightness. Both models consider the main cause of migration to be the expected wage and not the current wage differences. These models provided inconsistent and overestimated results in certain countries (Simionescu, 2016). Sipavičienė and Stankūnienė (2013) provide more general conclusions that social and economic problems are the main causes of emigration in developing countries. The expected relationship between emigration and the economic situation is that the undeveloped economies, with low employment rates, lead to higher emigration rates. Such a result was confirmed by Rayevnyeva et al. (2023), who used time-series analysis and VAR models to show a link between GDP and migration. However, the literature shows multiple examples of the opposed relationship. In a recent study in Romania, it was found that even low unemployment rates and increases in GDP have not stopped the migration tide (Stoian et al., 2017). Even if conclusions about the impact of the economic situation on migration are inconsistent, the economic factor should be included in multivariate modelling of migration.

Williams and Hall (2000) believe that tourism and migration both overlap and interrelate. Within the discourse, it is discussed that migration generates tourism flows, especially through visiting friends and relatives (VFR) (Okafor et al., 2022), which can, at the same time, cause an additional labour demand (Gössling and Schulz, 2005). What is also noted is that increased tourism draws capital inflow, which can in turn lead to more investments, improvement of the economic situation and wellbeing, and attract immigration (Přívarová et al., 2022). The nexus between tourism and migration should be observed not just through VFR, but through non-VFR. Massidda et al. (2015) in their study on the impact of migration on Italian inbound tourism used the dynamic panel data analysis and observed separately the VFRs and non-VFRs. They conclude that the link between migration and tourism is strong and goes beyond the VFR channel. Balli et al. (2016) analysed tourism flows from Organisation for Economic Co-operation and Development (OECD) countries to middle- and low-income countries and showed that immigrants residing in OECD countries have a positive advertising effect on their home countries, inducing tourism flows from OECD countries. The studies presented confirm the nexus between tourism and migration, with limited attention to the reciprocal effects of tourism on migration.

Agriculture and human migration have several mutual linkages that co-construct and shape each other (King et al., 2021). In this study, it is of particular interest to focus more closely on the link between the share of agricultural land and migration. Results in this nexus are also inconclusive. Xiao and Zhao (2018) examined the pattern in China and showed that an increase in a household's agricultural land tends to increase young household members' propensity to migrate to work in cities. In Nepal, the contraction of agricultural land in some mountainous districts drove migration from rural land (Maharjan et al., 2020). Hailu and Rosenberger (2004) on their county-level analysis in West Virginia, did not find the agricultural land to be a significant determinant of population and employment migration patterns. Overall, the relationship between agricultural land and migration remains highly context-dependent, with studies showing that agricultural land can both encourage and discourage migration depending on local economic and demographic conditions.

Many of the above-mentioned studies examined the impact of climate change or the national economy on migration. These studies provide valuable insights, but the question arises: can we simultaneously observe the impact of multiple factors on migration? Among the available quantitative methods, structural equation modelling (SEM) stands out. In a recent theoretical study, SEM was even identified as an important and valuable tool for future migration research (Nawyn et al., 2024). So far, multiple models have been proposed and verified using SEM. Pietrzak et al. (2012) modelled the migration flows between subregions (NUTS 3) in Poland in the years 2008-2010 using the following indicators: Gross Domestic Product (GDP) per capita, Number of entities in the national economy per one hundred citizens, Investment outlays on fixed assets per capita, Fixed assets in enterprises per capita, Registered unemployment rate, and Average monthly gross payment in the national economy. They coupled SEM with a gravity model and showed that hypothesised relationships are statistically significant, with the model of medium quality. De Longueville et al. (2019) modelled direct and indirect impacts of environmental factors on migration in Burkina Faso. Their longitudinal model, based on individual-, community-, and climate-level data, indicated that environmental factors are less influential than other macro-drivers of migration. Khalid and Urbański (2021) investigated the migration flows between Poland and Thailand. The model they proposed showed that economic factors (unemployment, poverty, and high wages) were statistically significant predictors in both models, while the significance of environmental factors was underwhelming. A longitudinal partial least squares structural equation model (PLS-SEM) was applied to Romanian migration flows to 21 EU member states by Mihai and Novo-Corti (2022). They found that economic, social, and technological factors impact migration. To the best of our knowledge, no SEM models have been proposed or estimated for data from the Republic of Serbia. Understanding the complex mechanisms of factors that impact migration may be particularly relevant in Serbia in recent years.

3 Country-specific case study: The case of Serbia

According to the EU nomenclature of territorial units for statistics (NUTS), Serbia is divided into two NUTS 1 (macro) regions, four NUTS 2 regions, and 25 NUTS 3 subregions or districts (Eurostat, 2025). The map of Serbia, along with the map of its NUTS 3 level districts, is shown in Figure 1, while the full list of district names and codes is provided in Appendix 1.

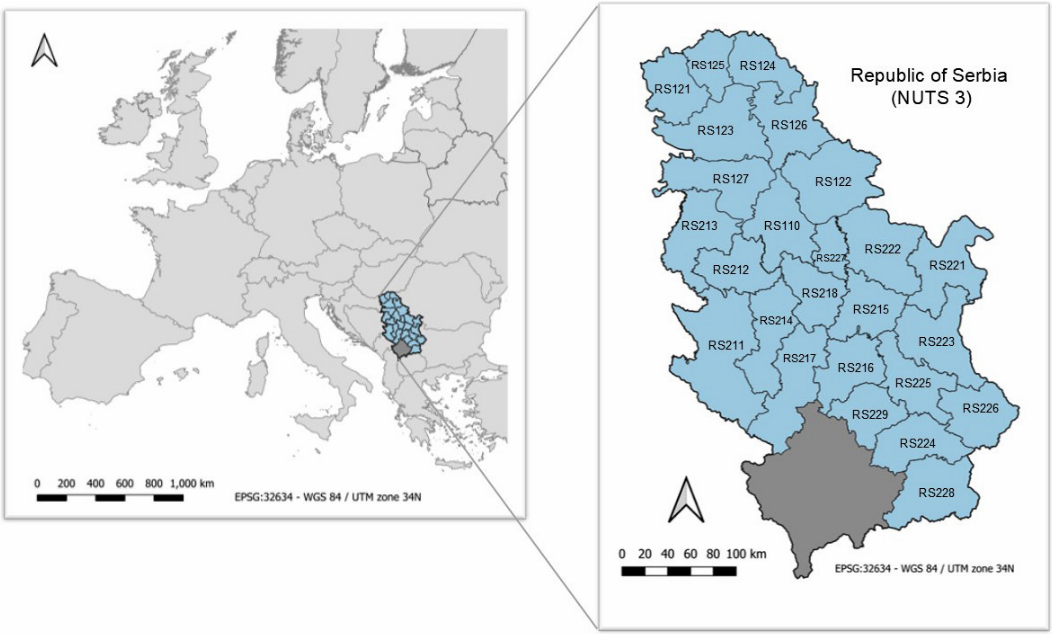

Figure 1: The map of Serbia alongside the map of its NUTS 3-level districts

Note: Administrative boundaries used for map preparation were obtained from Eurostat (2023), United Nations Office for the Coordination of Humanitarian Affairs (OCHA, 2024a; 2024b; 2024c), HDX, UK Government (2021) Open Data, and GeoSrbija (Republic Geodetic Authority, 2023). Maps were designed in QGIS 3.36.3.

According to the Statistical Office of the Republic of Serbia (2024), Serbia's population in 2024 was 6,586,476, with an annual population growth rate of -5.7 per 1,000 people. For many decades, Serbia has been characterised by a declining population, driven by low birth rates, population ageing and ongoing migration (Marinković et al., 2025). Serbia has a long emigration history with different phases, each with a specific dynamic and destination (Vuković, 2005). Looking at more recent migration, disparities in emigration are evident at multiple territorial levels, from municipalities and districts to the broader macro-regions of Central Serbia and Vojvodina, illustrating the highly heterogeneous nature of migratory dynamics across the country (Predojević-Despić and Penev, 2016). A recent study, which combined GIS and remote sensing to predict the dissipation time of rural settlements in Serbia, showed that the province of Vojvodina, the Belgrade region, Western Serbia, Eastern Serbia, Southern Serbia, and their districts are affected by the high effects of climate change (Valjarević, 2025). According to the provided predictions, the percentage of rural settlements that will be dissipated, until 2050, will range from 14.2% in the Belgrade region to 39.2% in Southern Serbia. The same author suggests more effective migration policies and spatial planning to reduce emigration rates.

The economic outline of the Republic of Serbia in 2024, according to the Statistical Office of the Republic of Serbia (SORS), is as follows: GDP per capita ($) 13,679.2, annual GDP growth 3.9%, with an unemployment rate of 8.6% in the IV quarter of 2024 (SORS, 2025b). Looking at the previous period (2010-2017), compared to neighbouring countries and the EU, Serbia had the lowest average employment rate (Đokić and Jovanović, 2019). Nevertheless, a recent study indicated that the overall economic situation is slowly improving, especially in the labour market (Marjanović and Zubović, 2020). Nevertheless, regional discrepancies in the economic development of regions and districts are highly present (Uvalić and Bartlett, 2021). Looking at salaries, they essentially stagnated in Serbia between 2008 and 2016 (Kosanović et al., 2017). The same authors list as many as 16 issues that could have led to the decrease in wages in the period. Overall, Serbia's economy in 2024 shows signs of steady improvement, particularly in employment, while still reflecting notable regional disparities and a legacy of long-term wage stagnation.

As for climate change, environmental conditions in Serbia have been undergoing continual degradation. Over recent decades, Serbia has experienced a steady rise in average annual temperatures, which, after 1998, surpassed historical norms and entered a distinctly warmer category (Crnčević et al., 2020). Previous studies on aridity trends in Serbia have yielded inconsistent results: some found no change in aridity, while others reported a slight increase in annual precipitation (Gocić et al., 2025). Official national report states that in the period 1980-1990, there were 2000 natural hazards, while in the next decade (1990-2000), there were 2800 (Official Gazette of the Republic of Serbia, 2011). More recent official analytical assessments remain unavailable. In response to the rising risk of natural disasters, the Disaster Risk Register of the Republic of Serbia (DRRRS) was launched in 2022 through a donation from the European Union (DRRRS, 2025).

According to the most recent SORS data, in 2024, there were a total of 12,662,151 tourist nights in Serbia, with 6,564,402 local and 6,097,749 foreign nights. The countries whose tourists spent the most nights in Serbia in 2024 were the Russian Federation (622,381), Türkiye (603,787), and China (404,047) (SORS, 2025c). Both the academic and the decision-making community in Serbia are placing significant attention on the competitiveness (Pavluković et al., 2024), branding (Novčić et al., 2012) and reputation (Maričić et al., 2025) of Serbia as a tourist destination. When analysing the data on the number of foreign nights in Serbia, one should consider the "diaspora tourism" (Huang et al., 2018). Serbia is perceived as a country with pronounced emigration and an extremely large diaspora, with estimations of 4.5 million people living outside the country (Đukić and Bodroža, 2022). As tourism contributed 2.0% of Serbia's GDP in 2023 and employed 4.8% of total employment in 2024 (Chamber of commerce and industry of Serbia, 2025b), it is an important sector of the national economy.

The Chamber of Commerce and Industry of Serbia, in their report, stated that in 2023, 6.8% of Serbia's GDP is attributable to agriculture (2025a). Differences in average farm size, production structure and production value between farms located in the north and the south of Serbia are notable (Stojanović, 2022). In 2018, in Serbia, there were 3,475,894 hectars of agricultural land, while in 2023, that surface reduced to 3,239,374 (SORS, 2025a). Having in mind that the surface of the agricultural land is decreasing and the importance of agricultural production for the GDP, the research on efficiency (Lukić et al., 2021) and competitiveness (Dimitrijević et al., 2023) of the sector is increasing.

4 Conceptual model development and research outline

4.1 Proposed conceptual model

The proposed conceptual model posits the Emigration rate as the central dependent variable, explained by four distinct predictors. The chosen predictors aim to capture the *Labour market*, *Environmental factors*, the impact of tourism (*Tourist overnight stays*), and the state of agricultural land (*Share of agricultural land in use*). The subsequent sections present the rationale for including each predictor, how the predictors are quantified, and how the hypotheses were derived.

According to Kahneman and Tversky (1979), migration decisions depend on recent shifts in how individuals rationally perceive current and future economic and labour market conditions in both the origin and destination cities, regions or countries. Therefore, we believed that a labour-market factor should be incorporated into the model. To quantify the *Labour market*, we focused on two indicators: the *Employment rate* and the *Average salary*. Employment rate has been used in the system dynamic panel estimation of migration done by Czaika (2015), while the effect of salaries was analysed in the work of Okeke (2014). Drobnjaković et al. (2022a), in their study of Serbia, showed that municipalities that experienced economic downturns in recent decades experienced intensive emigration. Therefore, we hypothesise:

H_1: Labour market has an impact on the internal outmigration rate in Serbia

Within the *Environmental factor*, we focused on three indicators: Average number of tropical days, Selyaninov hydrothermal coefficient (HTC), and Standardised Precipitation and Evapotranspiration Index (SPEI). A tropical day is defined as a day with the daily maximum temperature above 30°C according to the Digital Climate Atlas of Serbia (Digitalni atlas klime Srbije, 2025). A recent study on extremely warm temperature events in Serbia used this metric and showed that warm events, based on daily maximum temperatures, were becoming more extreme (Tošić et al., 2021). In our study, we used the HTC to assess aridity. This index has been used in previous studies to assess the aridity and precipitation in Serbia (Gocić et al., 2025). Among the several drought indices that are available, like the Palmer Drought Severity Index (PDSI) or the Standardised Precipitation Index (SPI), we opted for the SPEI as it is perceived to identify droughts in the context of global warming (Wang et al., 2022) and agriculture, especially in Serbia (Bezdan et al., 2019). Based on the definitions of the selected indicators, all of them capture aspects of rising temperatures and drought conditions, reflecting a negative impact on agricultural productivity. Several considerations motivated the decision to focus specifically on temperature-related impacts. An extensive review of the literature indicates that drought constitutes a recurrent natural hazard in Serbia, with the frequency and severity of extremely dry years increasing notably over the first two decades of the twenty-first century (Gocić and Amiri, 2023; Gocić and Trajković, 2013; Jovanović et al., 2013). The SPEI has recently been used to assess the spatial and temporal characteristics of drought in Serbia (Filipović et al., 2025). The mentioned study identified several drought periods (1961–1963, 1971/72, 1987–1993, 2000–2003 and after 2011) out of which two are covered by our dataset (2000–2003 and after 2011) and concludes that generally observing the SPEI tends to show longer and more severe dry periods in Serbia. We hypothesise that:

H_2: Climate factors have an impact on the internal outmigration rate in Serbia

The influence of tourism on emigration was assessed using the indicator Tourist overnight stays. Tourism development can function as a strong factor in migration dynamics. On the one hand, increased tourist activity in less-developed or developing regions may generate substantial socioeconomic benefits for local communities, thereby improving livelihood opportunities and potentially reducing outward migration pressures (Zhenhua, 2003). Conversely, large, popular tourist centres attract transnational (lifestyle migrants and digital nomads) and national migrants (Cocola-Gant and Lopez-Gay, 2020). At the same time, as a consequence of overtourism, depopulation of local communities has been observed, for example, in Seville, Spain (Diaz-Parra and Jover, 2020). In a recent study on seasonal migrations in rural Serbia, tourist activity was identified as the primary driver (Drobnjaković et al., 2022b). However, evidence from some small towns indicates that tourism's influence on population growth or migration remains stagnant, even as employment in the tourism sector rises (Stojanović et al., 2017). Having in mind inconsistent and contrasting results, we hypothesise:

H_3: The level of tourism activity has an impact on the internal outmigration rate in Serbia

Finally, the impact of agriculture on the emigration rate was examined through the *Share of agricultural land in use* (%). The interest in the agriculture–migration nexus has increased in the last five years (Corrado et al., 2024; King et al., 2021). These studies postulate that adverse climate-related effects on food production undermine local livelihoods, thereby prompting rural populations to migrate either internally or internationally. At the same time, with modernisation, technological and capital improvements, agricultural productivity rises and reduces rural labour demand, creating surplus labour that is pushing migrations toward urban areas (Drobne et al., 2013; Tuholske et al., 2024). In Serbia, in the Vojvodina region, the agrarian heart of the country, the percentage of individuals engaged in agriculture reduced from 13.6% in 1991 to 4.4% in 2011 (Bubalo-Živković et al., 2018). According to the same authors, one of the reasons for this occurrence was also deagrarisation. Another study done in Serbia, on the Južna Morava river basin (Manojlović et al., 2021), showed that migration from mountainous areas to urban centres led to widespread abandonment of farmland and that between 1961 and 2011, the population fell by 0.87% per year, agricultural land by 1.2% per year, and arable land by about 1% per year. The final model-derived hypothesis is:

H_4: The level of agricultural land in use has an impact on the internal outmigration rate in Serbia

The proposed conceptual model is presented in Figure 2.

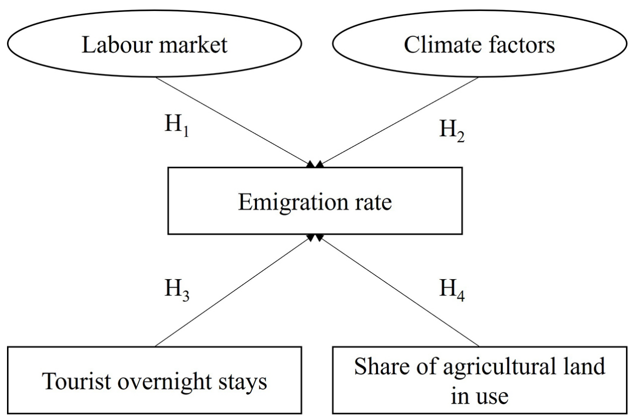

Figure 2: Proposed conceptual model

The proposed conceptual model assumes that internal outmigration is shaped by a combination of economic, environmental, and structural regional conditions that influence individuals' decisions to remain in or leave a district. Each of the model constructs captures a distinct dimension of regional development that may affect population mobility and local livelihood opportunities. The labour market latent construct was operationalised using two indicators capturing both labour market participation and income conditions. Together, these indicators provide a broader representation of labour market performance by combining both the quantity and the economic value of employment. Climate projections for Serbia indicate increasing drought hazards in the future (Thow et al., 2022), which may intensify risks of desertification and land degradation. These processes create economic and social challenges by reducing soil productivity, food availability, biodiversity, and ecosystem functioning. Therefore, *Climate factor* latent variable is included in the model. Agricultural land use represents an important indicator of production patterns. In this study, the indicator highlights the expansion of uncultivated and forested land, which may affect household income and employment opportunities (FAO, 2025; Tubiello et al., 2023). Finally, *Tourist overnight stays* are used as an indicator of tourism activity, reflecting the sector's contribution to regional economic dynamics.

4.2 Research methodology

The data were collected at the district-year level, meaning each row in the dataset represents the state of a district in a specific year. In total, 25 districts (NUTS 3) were observed, covering the entire national territory except the Autonomous Province of Kosovo and Metohija. This region and its districts are excluded from the analysis due to the unavailability of the official statistical data[1]. All data was collected for the period 2000-2024. There were no missing data, so no amputation methods were used, and there were no issues with the application of the SEM algorithm.

The overall model comprises eight indicators: *Emigration rate (‰), Employment rate (%), Average salary (RSD), Average number of tropical days (days), HTC, SPEI, Tourist overnight stays (days),* and *Share of agricultural land in use (%).* The data was acquired from Digital Climate Atlas of Serbia (*Average number of tropical days, HTC, SPEI*) (Digitalni atlas klime Srbije, 2025), and documents published by the Statistical Office of the Republic of Serbia (the remaining five indicators). R open source software was used for data analysis.

As described above, the variables constituting the model are measured in different units and on different scales. SEM analysis estimation algorithms are sensitive to the scale on which the variables are measured (Klopp and Klößner, 2021). Large differences in scales and variances can potentially lead to inadmissible solutions and poor model fit (Lee and Song, 2004). Therefore, in our methodological approach, variable transformations were applied prior to model estimation. Specifically, three variables exhibited right-skewed distributions with substantially larger variances relative to the other indicators: *Average salary*, *Tourist overnight stays*, and *Average number of tropical days*. A natural logarithmic transformation was applied to each to reduce skewness, compress the range of values, and bring their variances closer to those of the remaining variables in the model. Furthermore, the log-transformed Average number of tropical days was reverse-coded by multiplying by −1, so that higher values indicate fewer tropical days.

[1] *The 2002, 2011 and 2022 censuses were not conducted on the territory of the Autonomous Province of Kosovo and Metohija by the Statistical Office of the Republic of Serbia (SORS, 2025d)*

This aligns its directionality with the other indicators of the *Climate factors* latent construct (HTC and SPEI), where higher values represent more favourable climatic conditions. Without this reversal, the indicator would load in the opposite direction, undermining the interpretability of the latent factor.

To verify the outlined conceptual model and accept or reject the defined hypothesis, we used Structural Equation Modelling (SEM). SEM analysis can be defined as a statistical multivariate analysis that is based on the principles of factor analysis and multiple linear regression (Kline, 2023). Even though the SEM was initially proposed to analyse ordinal and scale data, advanced algorithms have been developed that allow its application to longitudinal and panel data (Little et al., 2007). One such algorithm is the cluster-robust Huber–White estimator (Huber, 1967; White, 1982). When running this algorithm, the prerequisites are that there are at least 20 clusters and that they are balanced and equal in size. Another aspect to mention is the “cluster” approach. Here, the "clustered" dependence is observed, where the observations are grouped in known "clusters" and assumed to be independent across clusters but arbitrarily correlated within (Powell, 2023). As we are observing 25 districts with longitudinal data, as outlined above, the cluster-robust Huber–White estimator was employed.

5 Results

5.1 Descriptive statistics

Before modelling and model evaluation, we first present the descriptive statistics of the variables included in the study. Table 1 summarises the key characteristics of all model elements, providing an overview of their central tendencies, variability, and internal validity.

To complement the descriptive statistics analysis and interpretation, we provide two appendices that should provide a better understanding of the modelling, results, and spatial distribution. In Appendix 2, we present the visualisations of average measured model elements per year. Figures 3–7 presented in Appendix 2 provide a comprehensive visualisation of the mean values of the proposed model indicators for the period 2000–2024. These figures illustrate the overall dynamics and long-term trends observed across the indicators, enabling a clearer understanding of their temporal patterns, fluctuations, and potential structural shifts.

Table 1: Descriptive statistics of the conceptual model elements

Element	Mean	Std	Median	Min	Max	Std Cronbach’s alpha
Emigration rate (‰)	Not calculated**			8.700	34.667	/
Employment rate (%)	Not calculated**			18.071	48.937	0.68
Average salary (RSD)*	Not calculated**			1,525	124,010	
Average number of tropical days*	35.783	17.222	35.808	2.299	82.512	0.91
HTC	1.124	0.399	1.047	0.285	3.131	
SPEI	-0.842	1.347	-0.925	-3.089	3.089	/
Tourist overnight stays (days)*	313,233.99	447,003.431	157,229.00	15,568	3,712,038	/
Share of agricultural land in use (%)	63.115	13.431	60.100	39.300	90.500	/

Note: *The logarithmic values of the marked variables were used to calculate Cronbach’s alpha, ** Each administrative unit carries a different weight and therefore regular descriptive statistics metrics were not calculated

The *Emigration rate* in the Republic of Serbia during the observed period had a vast range, from 8.70‰ (Zapadnobački district in 2001) to 34.66‰ (Toplički district in 2003). Interestingly, among the districts with the highest emigration rates, the City of Belgrade, the capital, accounts for seven of the ten highest recorded values. This pattern reflects the strong role of Belgrade as the country's dominant economic, administrative, and educational centre, which generates significant internal population mobility. At the same time, the elevated out-migration rates from certain districts may also indicate ongoing regional demographic imbalances and the concentration of employment and educational opportunities in major urban centres.

The *Employment rate* during the observed period also varied widely, from 18.07% (Jablanički district 2010) to 48.94% (Grad Beograd district 2024), indicating substantial variation in employment levels across regions. The average salary ranged from 1,525 RSD (Pirotski district, 2000) to 124,010 RSD (Grad Beograd district, 2024). Such a result could have been expected as the observed period captures the period of political and economic changes in the 2000s. Since that period, the average salary, measured in Serbian dinars (RSD), has been on an upward trend. The measured Cronbach's alpha for the two labour-market related indicators is 0.68. Even if the value is below the 0.7 proposed threshold, the result can be considered acceptable, having in mind that Cronbach's alpha is sensitive to the number of items within a scale (Tavakol and Dennick, 2011).

The *Average number of tropical days* varied from 2.3 to 82.5 per year. The similarity between the mean and median values indicates that the distribution is approximately symmetric and not markedly skewed. Nonetheless, the results suggest that certain districts experience a disproportionately high number of tropical days. The data indicate that 2024 had the highest incidence of tropical days (Figure 3), with the Srednjebanatski, Južnobački, Podunavski, Zapadnobački, Sremski, and Južnobanatski districts exhibiting the highest values. As expected, the mountainous Zlatibor district recorded the fewest tropical days (2018 and 2014).

The Hydrothermal Coefficient (*HTC*) describes the balance between precipitation and temperature during the vegetation period. The Selyaninov's hydrothermal coefficient (HTC) classification (Vlăduţ et al., 2017 (adapted from Selyaninov (1930)) is the following: 0.3—very dry or arid; 0.31–0.60—dry; 0.61–0.80—moderately dry; 0.81–1.00—slightly dry; 1.01–1.20—slightly humid; 1.21–1.40—moderately humid; 1.41–1.60—humid; > 1.61—very humid. During the observed period in Serbia, the average HTC was 1.12, which is optimal. The median of 1.05 also supports the claim. The minimum and maximum measured values indicate the districts that were too dry (Severnobanatski, Severnobački, and Zapadnobački districts in 2000) and water-saturated (Zlatiborski, Kolubarski, and Moravički districts in 2014). The year with the highest mean measured HTC was 2014 (Figure 4).

The mean *SPEI* value in Serbia for 2000-2024 was -0.84, with a standard deviation of 1.35. The negative value indicates that, on average, Serbia was experiencing drought. The minimum and maximum SPEI values were observed during the period, indicating both extreme drought and extreme wet conditions. The districts with drought were Sremski, Grad Beograd (in 2000), Severnobanatski, Podunavski, Južnobački and Sremski districts (in 2024), while the extremely wet districts were Kolubarski, Moravički, Šumadijski, and Zlatiborski districts (all in 2014). As for the HTC, the year with the highest mean measured SPEI was 2014 (Figure 5). For the three climate indicators, the measured Cronbach's alpha was 0.91, indicating good internal consistency.

Tourist overnight stays exhibit the widest range and the highest standard deviation, indicating significant differences among the districts in tourism attractiveness. The mean measured number of tourist overnight stays is 313,233.99 per year. The visibly lower median of 157,229.00 shows that a small number of districts attract disproportionately large numbers of tourists. The capital, Belgrade, is the absolute leader in attracting tourists (with the highest values in 2017, 2018, 2019, 2022, 2023, and 2024). Among the top 10 districts by tourist nights is also the Zlatiborski district (2023 and 2024). After a sharp decrease in overnight tourist stays in 2020 due to COVID-19 restrictions, overnight stays increased sharply in 2021, with the upward trend continuing through 2024 (Figure 6).

The mean *Share of agricultural land in use* was 63.12% with a standard deviation of 13.43%. The median is slightly lower than the mean. The measured range is from 39.30% (Borski district 2024) to 90.50% (Severnobački district 2002). Eastern Serbia and the Borski district are characterised predominantly by forests and pastures rather than extensive arable land. Also, it should be taken into account that the Borski district is a traditionally mining district that, to a certain extent, has limited agricultural activity. On the other hand, the districts of the Vojvodina region have almost all of their area as agricultural land. Between 2002 and 2013, the mean share of agricultural land in use oscillated around 66%. However, after 2013, a sharp decline began, resulting in a mean share of 55.4% in 2024 (Figure 7).

5.2 Conceptual model validation

The initial model demonstrated an acceptable fit to the data, with a Chi-square value of 465.482 (df = 17), a scaled CFI of 0.811, and a scaled RMSEA of 0.098. As all estimated relationships within the model were statistically significant, no structural modifications were undertaken. Although modification indices were computed, none were applied, as they suggested covariance relationships lacking theoretical justification. Consequently, the initial model was retained and accepted as the final model.

Given the sample size and the number of variables in the model, the Chi-square statistic can be considered low. The measured RMSEA is 0.098, which is borderline acceptable (Hu and Bentler, 1999). The scaled CFI is below the usually accepted threshold of 0.9 (Hu and Bentler, 1999). However, the 0.9 threshold was proposed for the models estimated using maximum likelihood (ML) and weighted least squares (WLS), without considering or adjusting for other estimation algorithms (Schermelleh-Engel et al., 2003). Relatively recent research raised concerns about the rigid application of universal fit index cutoffs (Marsh et al., 2004). Simulation studies have shown that traditional thresholds are sensitive to model complexity, sample size, and the number of estimated parameters, and may therefore be overly conservative under certain analytic conditions (Nye and Drasgow, 2011). Taken together, these considerations support retaining the model as substantively interpretable, despite the suboptimal fit indices.

The results of the measurement model assessment are presented in Table 2. Within the *Labour market* latent construct, *Employment rate* loads more strongly (0.820) than *Log Average salary* (0.559), suggesting that employment levels are a more prominent indicator of labour market conditions at the district level than salary levels. Both indicators contribute meaningfully to the construct, though the difference in loadings indicates that variation in employment rates captures more of the underlying labour market factor.

Observing the second latent factor, Climate factors, higher values on this factor reflect more favourable climatic conditions — characterised by lower heat stress and reduced drought intensity. Following the reverse-coding of the log-transformed average number of tropical days, all three indicators are aligned so that higher values correspond to less extreme conditions. The positive loadings of SPEI, HTC, and the reverse-coded tropical days indicator confirm that the construct captures a coherent underlying climate pattern, where higher factor scores correspond to cooler, wetter, and less drought-affected districts.

Table 2: Structure of the measurement model

Latent construct	Predictors	Std Coeff	Unstd Coeff	Z value	P value
Labour market	Employment rate	0.820	1.000	/	/
	Log Average salary	0.559	0.089	3.199	0.001
Climate factors	Log Average number of tropical days	0.810	1.000	/	/
	HTC	0.968	0.785	23.368	0.000
	SPEI	0.857	2.386	8.029	0.000

The structural model assessment is provided in Table 3 and provides the standardised coefficients (Std Coeff), unstandardised coefficients (Unstd Coeff), value of the statistics (Z-value), significance (p-value), and the coefficient of determination (R^2).

Table 3: Structural model validation

Dependent variable	Predictors	Std Coeff	Unstd Coeff	Z value	P value	R2
Emigration rate	Labour market	0.227	0.157	2.630	0.009	0.391
	Climate factors	-0.138	-1.063	-4.267	0.000	
	Log Tourist overnight stays (days)	0.445	1.607	3.272	0.001	
	Share of agricultural land in use (%)	-0.220	-0.062	-2.512	0.012	

The model assessment results indicate that all four predictors of the emigration rate are statistically significant. *Labour market* has a positive, strong and statistically significant impact on the *Emigration rate*. The obtained positive coefficient suggests that more favourable district-level labour market conditions are associated with higher emigration. This finding implies that economically stronger regions may also generate greater mobility potential. The *Climate factors* ($\beta = -0.138$) show a negative association with emigration, indicating that more favourable climatic conditions are associated with lower emigration rates. Regions with more extreme or stressful climatic conditions (e.g., drought and heat stress) exhibit higher emigration rates (for example, Grad Beograd and Zlatiborski okrug [2]). The results suggest that environmentally harsher conditions (more drought and hot days) do stimulate internal outmigration to a certain level.

The strongest observed driver of emigration in the model is tourism intensity, measured by tourist overnight stays ($\beta = 0.445$). The obtained result is consistent with the idea that more internationally integrated and service-oriented regions also exhibit higher outward mobility. Such regions may simultaneously attract population inflows while also fostering a population with greater capacity and propensity to emigrate. In contrast, the share of agricultural land in use reduces emigration ($\beta = -0.220$), suggesting that more agrarian regions tend to have more stable, less mobile populations. The four predictors explain 39.1% of the variability of the *Emigration rate*, which is considered satisfactory given that emigration is a complex phenomenon with multiple impacting factors.

[2] *An additional explanation for these two districts can be found in the publication (SORS, 2026)*

6 Discussion

The rising significance of the changed climate conditions affecting a wide range of human activities, social development, and migration within this was recognised in The program of adaptation to changed climate conditions for the period from 2023 to 2030 (Government of the Republic of Serbia, 2023). The general goal of this Program is to increase capacity to enhance resilience to climate change, thereby improving the well-being of people, the economy, and the environment. Within four specific goals, the first is to enhance knowledge and understanding of the impacts of climate change and its consequences, thereby improving research methodology and scientific evidence. Therefore, our research can provide insight into several important drivers of internal outmigration.

The main outcome variable in the proposed conceptual model is internal outmigration in Serbia. Based on the descriptive statistics of the measured *Emigration rate* for the period 2000-2024, the capital, City of Belgrade, showed the highest internal outmigration rate. This supports the claim that living in the capital city can act as a migration factor. A similar result was found in Romania, where the strongest emigration was not observed in less economically developed regions but in more developed ones, supporting the claim that living in the capital city can act as a migration factor (Liu et al., 2018). Further analysis, based on the SEM results reported in Table 3, shows that the labour market was a strong factor in emigration, with an estimated impact of 0.227, indicating that increases in average salary and the employment rate will lead to higher emigration from the district. The coefficient is statistically significant, supporting Hypothesis 1. This is not unusual in migration research, as stronger economies produce more mobile, skilled, and educated individuals with higher emigration potential. This is consistent with the collected data and results, which show that the Belgrade district has the highest emigration rate. In a review of various studies, the IOM (2005) points out that, in developing countries, internal economic development is actually positively correlated with outmigration, in other words, the most developed areas experience higher population mobility due to growing migration resources. In Serbia, the demographic explanation of such emigration flows is particularly important. Namely, the high emigration rate of the largest economic centres still results in a positive migration balance. In contrast, the lower emigration rate of less developed districts still results in a negative migration balance. In other words, a lower emigration rate does not necessarily indicate a positive outcome, in both demographic and economic terms, as highlighted in the Study on external and internal migration of citizens of Serbia (Bobić et al., 2016). Also, the presented results should be examined in light of Serbia's sociopolitical and economic situation. Namely, even if the average salary, measured in RSD, increases due to high inflation and rising costs of living, it is still not a strong enough pull factor for individuals to stay, especially for younger generations, Millennials and Gen Z (Jurić, 2021). The obtained result is also in line with de Haas's (2010) theory, which proposes an aspirations–capabilities framework and the idea that the early stages of development, including higher incomes and a better labour-market situation, can raise both aspirations and capabilities to migrate. The theory was additionally supported by Benček and Schneiderheinze (2024) using panel data analysis. The authors concluded that economic growth increases migration in poor countries, but that systematic country differences should be considered when interpreting the results.

The modelled *Climate factors* focused on the aridity, high temperatures, and drought (Table 2). The estimated impact of *Climate factors* on the emigration rate was negative and statistically significant (β = -0.138). Besides the Belgrade district, highly climate-vulnerable districts include Central Banat, Zaječar, Bor, and Pirot. Among them, only Bor records high emigration levels, likely due to more favourable labour market conditions that increase emigration potential, as previously noted for the Belgrade district. The remaining three districts are characterised by very old populations that rarely resettle. In Serbian districts, higher temperatures increase emigration. A slightly different result was found in the study by Gligorijević and Bakić (2025), who showed that, in Serbia, after the 2014 flood, contrary to expectations, emigration rates in environmentally threatened districts decreased, and this trend has continued to the present day, however they observed a different environmental threat. Martínez-Zarzoso et al. (2023) analysed the link between climatic events and migration using the gravity model panel data. One of their conclusions is that droughts reduce out-migration from arid and semi-arid regions. A recent systematic literature review encompassing papers published in Web of Science from 1976 to 2023 notes that 15% of analysed papers reported a decrease in mobility, even when climatic stressors were present (Link et al., 2025). Another perspective from which the results can be interpreted is that higher temperatures correlate with higher urbanisation rates (Helbling and Meierrieks, 2023). Therefore, individuals would be prepared to remain in warmer districts due to their proximity to industry, technology, and urbanised settlements. Thus, the detected negative relationship between climate factors and emigration does not contradict broader theory but highlights the need to interpret environmental impacts on migration within Serbia's specific territorial and socioeconomic context. All presented signals indicate that individuals with resources are those who migrate, not those who are directly environmentally threatened.

The results presented in Table 3 indicate that higher tourism activity is associated with higher emigration rates, supporting Hypothesis 3 (β = 0.445). Tourists' income allows the local population to interact more with both foreigners and nationals from other cities and regions of Serbia and become more aware of potentially better economic opportunities in other cities across Serbia, a higher quality of life, and alternative lifestyles, all of which can increase aspirations to emigrate. This phenomenon is called aspirational migration (Carling and Schewel, 2018). Tourism-led development may also create a migration effect. Namely, increased tourism can raise the local cost of living, generate seasonal, unstable jobs, and exacerbate spatial inequalities. Evidence of such a negative impact of tourism has been observed in Spain, mainly due to the increased number of shared accommodations in the city's historical areas (Cocola-Gant and Lopez-Gay, 2020). According to the results presented, a similar trend is evident in Serbia, particularly after a sharp rise in overnight stays from 2021 (Figure 6). Since the COVID-19 pandemic, the number of local tourists' overnight stays has also risen, additionally contributing to the aspiration for internal emigration.

Hypothesis 4 has also been confirmed, stating that the share of agricultural land impacts the emigration rate. Although the share of agricultural land in use is generally declining, the observed negative coefficient indicates that emigration tends to be lower in predominantly agricultural districts, likely due to stable agricultural activity and a comparatively limited demographic pool for migration. These districts located in the Autonomous province of Vojvodina, plus the Podunavski district, record a larger share of agricultural land in use, and lower emigration rate compared to other districts. A higher proportion of agricultural land typically reflects more intensive or stable agricultural activity, which can provide residents with reliable sources of income and employment. In rural areas where agriculture remains a dominant economic sector, the availability of land-based livelihoods can serve as a stabilising factor, reducing incentives for individuals to migrate elsewhere. In other words, when agricultural opportunities expand, the economic pressure to move, either domestically or internationally, tends to weaken (Khatir and Rezaei-Moghaddam, 2014). Also, very important, evidence from Serbia indicates that the population engaged in agriculture tends to be more attached to their place of residence (Solarević et al., 2023). The share of agricultural land in Serbia has declined during 2000-2024 (Figure 7), so if the trend continues, district-level emigration will increase. One example is a study examining the relationship between migrants and their place of origin in eastern Serbia, which shows that, despite similar drivers behind the decline of agricultural activity, the sociodemographic characteristics of migrants themselves shaped migration patterns both within and beyond the local area (Vasić and Repedžić, 2025).

In addition to analysing each hypothesis and its acceptance, it is worth discussing the overall model. The proposed conceptual model showed a solid fit to the data and explanatory power. Namely, as much as 38.5% of the variability of the *Emigration rate* was explained by the four predictors. Many studies that employ SEM to explore migration do not report the R-square value. The percentage of explained variability obtained is somewhat lower than that reported by Amudhan et al. (2024), whose model had an explanatory power of 56%. It should be noted that their model was based on survey data rather than district or GIS data, which may have affected its results. The structures of the two latent constructs are stable, as are the hypothesised impacts on the emigration rate. Overall, the model provides promising, useful, and valuable insights.

The results underscore that emigration in an emerging economy is not driven by a single dominant mechanism but by the combined and partly countervailing effects of labour-market conditions, climate-related stressors, tourism intensity, and the agricultural structure. In particular, the coexistence of enabling economic conditions, environmentally differentiated territories, tourism-led openness, and stabilising agricultural contexts illustrates the need for multidimensional policy approaches. This shows that the model supports the proposed framework and demonstrates how useful SEM is for separating the factors that influence migration, especially in countries with large regional differences.

7 Conclusion

The study and the model contribute to the current literature in several ways. First, it provides an analysis and a longitudinal overview of the economy, environment, and migration in the understudied developing country of the Republic of Serbia. Migration determinants vary by country, so the provided insights should be interpreted accordingly (Simionescu, 2016). Second, it proposes a conceptual model to capture the complex causal relationships among factors that impact migration. Finally, the proposed model is easily adaptable to countries, regions, and cities and can be extended to include other factors and constructs.

The main conclusions are that a favourable labour market increases migration potential; high levels of agricultural activity reduce emigration, both directly through attachment to the land and indirectly through the typically unfavourable age structure of the agricultural population; and the tourism significance of a district influences migration by creating opportunities for its realisation. Furthermore, the impact of unfavourable climatic conditions varies across contexts: in districts with high agricultural activity and older populations—where mobility is generally lower—the effect is more pronounced, whereas in highly urbanised areas (e.g., Belgrade), it is mitigated by other favourable, non-climatic drivers that encourage migration.

The results, although promising, should be interpreted with an acknowledgement of their limitations. The first potential limitation concerns the level of observation. The use of aggregated district-level data, while consistent with the available official statistical data in Serbia, may mask important within-district heterogeneities, as each district encompasses municipalities with potentially divergent demographic, economic, and infrastructural profiles. Consequently, the estimated relationships should be interpreted as reflecting aggregate tendencies rather than granular, municipality-level processes. Previous studies have documented significant socio-economic differences both between and within districts in Serbia (Radovanović et al., 2023), further underscoring the risk of oversimplified conclusions from aggregated data (Lee et al., 2025). Future research would benefit from adopting a more disaggregated analytical framework to capture local specificities and to examine whether the structural relationships identified in this study hold across different spatial scales. An additional future study could assess the model per region and subsequently apply the multi-group SEM (MG-SEM) to test whether there are statistically significant differences in the estimated coefficients across the models within each region (Maričić et al., 2025). It would also be beneficial for policymakers to have a grouping of districts based on the labour, climate, and migration patterns. Segmentation of districts using clustering or more advanced biclustering algorithms (Nikolic et al., 2022) is a promising future direction for the study. Another direction for the research, aligned with policymakers' potential needs, is to propose a district ranking based on multivariate analysis. Promising ranking methods include the Ivanović distance (Ivanovic, 1973), initially proposed for ranking regions, related methods such as the Composite I-distance Indicator (Dobrota et al., 2015) or eSS-CIDI (Maricic, 2019), and more advanced methods for ultrametric composite indicators (Cavicchia et al., 2024). An index of population dynamics has already been proposed (Indaco and Ortega, 2024). Considering and combining the suggested avenues for further research will help extend the important research stream on causal mechanisms linking climate and the economy on the one hand, and population dynamics on the other. A final note is a comment on the limitation of this study, which concerns the model fit, as several SEM fit indices fall below traditionally recommended thresholds. Although recent methodological arguments support a more flexible interpretation of these values, this remains a noteworthy constraint, and the findings should be interpreted with a certain level of caution. However, as all hypothesised structural paths in the model were statistically significant and theoretically consistent, the proposed framework is believed to capture meaningful relationships in the data.

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Appendix is accessible at https://geodetski-vestnik.com/arhiv/70/3/Appendix_1

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