“Staying for the Scenery? The Impact of Nature on Migration in Bulgaria”

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Abstract: This study investigates the relationship between nature and migration across Bulgaria’s 28 NUTS-3 regions between 2010 and 2019. Using a two-stage regression approach, the analysis first models net migration as a function of time-varying economic factors, then explains the resulting regional fixed effects using time-invariant characteristics such as the percentage of protected nature, elevation, climate, and population density. The findings suggest that regions with a higher share of protected natural areas experience slightly less out-migration, indicating the potential of environmental amenities to mitigate population decline. While the study focuses on Bulgaria, its findings have broader implications for other European countries facing similar demographic challenges. As Europe enters a period of expected population decline, especially in peripheral and rural areas, leveraging environmental assets could become a valuable strategy for retaining residents and supporting regional resilience.

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1 Introduction

Migration has been a constant in human history, shaping populations and societies across time and space. Its enduring relevance has led to extensive scholarly attention from a wide range of disciplines, levels of analysis, and methodological approaches (Czaika & Reinprecht, 2020; Journal of Migration History, n.d.; Minority Rights Group, 2020). Migration has been studied at both international and subnational scales, with researchers identifying a core set of drivers: economic, social, demographic, infrastructural, political, and environmental/geographic factors (European Parliament, 2020; Nishimura & Czaika, 2023).

Among these core drivers, economic indicators particularly income and employment opportunities are consistently found to be central determinants of migration (Jennissen, 2003; Langella & Manning, 2021). The Organisation for Economic Cooperation and Development (OECD), for instance, has highlighted regional income differentials as a key factor in interregional migration flows (OECD Economics Department, 2021).

In parallel to economic drivers, several studies have examined the influence of social, cultural, demographic and political variables on migration decisions. For example Mihai and Novo-Corti (2020) find that cultural distance impacts migration flows in Europe, focusing on Romania; they show that greater cultural distance leads to smaller migration flows. Demographic characteristics also play a significant role, Poutvaara (2021) suggests that high population growth can serve as a push factor, whereas Zaiceva (2014) finds that aging populations tend to reduce migration intensity. Accessibility and infrastructure are additional factors shaping migration patterns (Li et al., 2014; Zhang et al., 2024). Voss and Chi (2006) show that highway expansion in the United States has contributed to regional population growth, underscoring the importance of physical infrastructure in shaping migration dynamics. Political conditions can also influence migration decisions (Winter, 2019). Political instability, corruption, and conflict often function as push factors (Simpson, 2022), while political freedoms and access to legal rights can act as pull factors (Czaika & Reinprecht, 2020; Simpson, 2022).

Environmental and geographic factors also play a role in shaping migration decisions. However, existing research often emphasizes risks such as natural disasters and climate-related displacement (Czaika & Reinprecht, 2020), while relatively little attention has been paid to the other potentials of nature such as landscape attractiveness, biodiversity, clean air, and other impacts of living nearby nature areas as potential pull or push factors. This paper addresses that gap by focusing on the role of nature and geography in migration decisions, especially in a regional European context.

Importantly, migration drivers are not universally applicable; their significance varies across regions and over time due to the complex interplay of dynamic, multi-causal, and context-specific forces (Minority Rights Group, 2020). Liu et al. (2017), for example, find that per capita Gross Domestic Product (GDP) had opposite effects on rural population change in China between 1990–2000 and 2000–2010. Similarly, the demographic context such as population aging can produce divergent migration patterns across world regions (Poutvaara, 2021). These findings underscore the context-dependent nature of migration dynamics and the need for region-specific analyses.

This study focuses on Bulgaria, a country experiencing significant population decline and internal migration, shaped by its post-socialist transformation and EU accession ("Social Impact of Emigration and Rural-Urban Migration in Central and Eastern Europe," 2012; Fihel & Okólski, 2019). Despite the scale of these demographic changes, limited research has been conducted on the role of natural amenities in shaping internal migration patterns within Bulgaria or similar Eastern European contexts. Moreover, the potential of natural factors to mitigate depopulation trends remains largely unexplored.

Natural amenities have been studied increasingly in recent years. The paper by Schaeffer and Dissart (2017) shows that there is growing interest in evaluating how nature impacts regional development and quality of life. Eurostat also states that natural amenities play a significant role in the quality of life for European citizens (Quality of Life Indicators, 2025). The U.S. Department of Agriculture highlights that natural amenities are important for both migration patterns and regional development, emphasizing the role of attractiveness in population movements (Natural Amenities, 2025).

This paper does not attempt to measure each of these amenities separately but instead focuses more broadly on nature itself. Specifically, it uses the percentage of protected nature areas as a standardized proxy for the presence of natural environments at the regional level across Bulgaria. While this does not directly capture specific amenities such as recreational accessibility or aesthetic beauty, it reflects the broader availability of natural land and the policy commitment to its conservation. It is important to acknowledge that protected areas differ widely in the type and intensity of amenities they offer. Some may be easily accessible and well-integrated into daily life, providing clear recreational or visual benefits, while others may be ecologically valuable but less visible or usable for residents. Nonetheless, using protected area coverage provides a meaningful and comparable indicator of nature presence across regions.

The expectation is that a greater share of protected nature may contribute to regional attractiveness and reduce outmigration. However, the paper maintains an open perspective: protected status may also introduce constraints, such as stricter land-use regulations or development limits, which could dampen or even reverse its positive effects in some cases. The analysis therefore seeks to empirically assess the net effect of nature, via protection status, on population dynamics in Bulgaria.

Given that several European countries are projected to face long-term population decline (Population Projections in the EU, 2023), understanding how nature influences internal migration is not only of academic interest but also of practical relevance for regional development and spatial planning. This study contributes to the literature by applying a two-stage econometric modeling approach, used in other economic fields but rarely in migration research, to examine how natural and geographic features influence regional migration patterns. By integrating this method with geospatial data, the analysis offers new insights into the structural role of nature and environmental factors in shaping migration dynamics.

In sum, the goal of this paper is to determine the importance of nature as a pull (or push) factor for migration in Bulgaria on a NUTS 3 level. In addition, this paper addresses three gaps in the literature: (1) the underexplored role of natural amenities in internal and international migration; (2) the lack of region-specific research for Bulgaria and similar post-socialist countries; and (3) the need for evidence on how nature might influence migration in the context of depopulation. Through this approach, the study aims to inform both academic understanding and policy responses to ongoing demographic change in Europe.

2 Demographic Context: Bulgaria's Population Decline

Bulgaria has experienced sustained population decline since the early 1990s, following the collapse of the Soviet Union. As shown in Figure 1, the country has lost approximately 25% of its population over the past three decades. This decline can be attributed primarily to two interrelated factors: persistently low birth rates and high levels of emigration driven by economic hardship and increased mobility after the transition to a market economy (Mladenov et al., 2008).

Figure 2 illustrates the components of population change namely, net migration and natural change over time. While the overall demographic trend remains negative, an important inflection point occurred in 2020: net migration turned positive for the first time in recent history. Simultaneously, the natural change component showed a sharp decline during the COVID-19 pandemic years (2020–2022) when 45,135 people died from the virus (*COVID-19 Deaths*, n.d.). However, the main explanation of this drop lies in the methodological changes following Bulgaria's 2021 Population and Housing Census. Prior to the census, population figures were based on statistical estimates derived from previous censuses, as well as recorded births, deaths, and migration data. The 2021 census provided a more accurate and updated count, revealing that earlier estimates had likely overstated the actual population probably due to unaccounted emigration and discrepancies in death reporting. The same goes for 2010.

Given the exceptional and temporary nature of the pandemic's demographic impact, this study restricts its focus to the period between 2010 and 2019 to ensure comparability and avoid distortions.

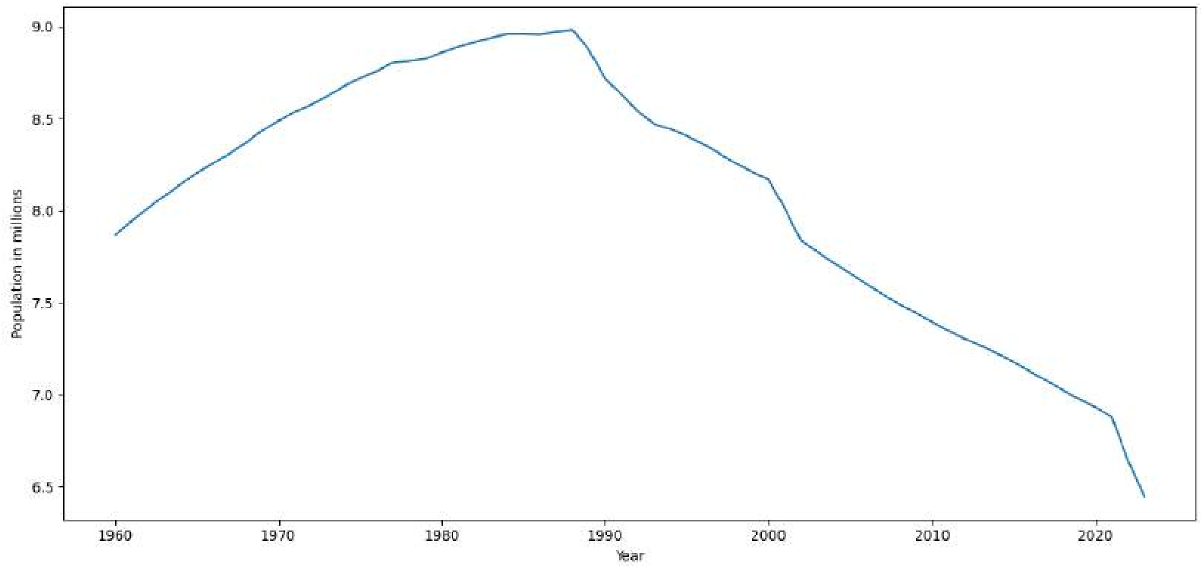

Figure 1, Population trend Bulgaria 1960-2023 (Source: World Bank Open Data)

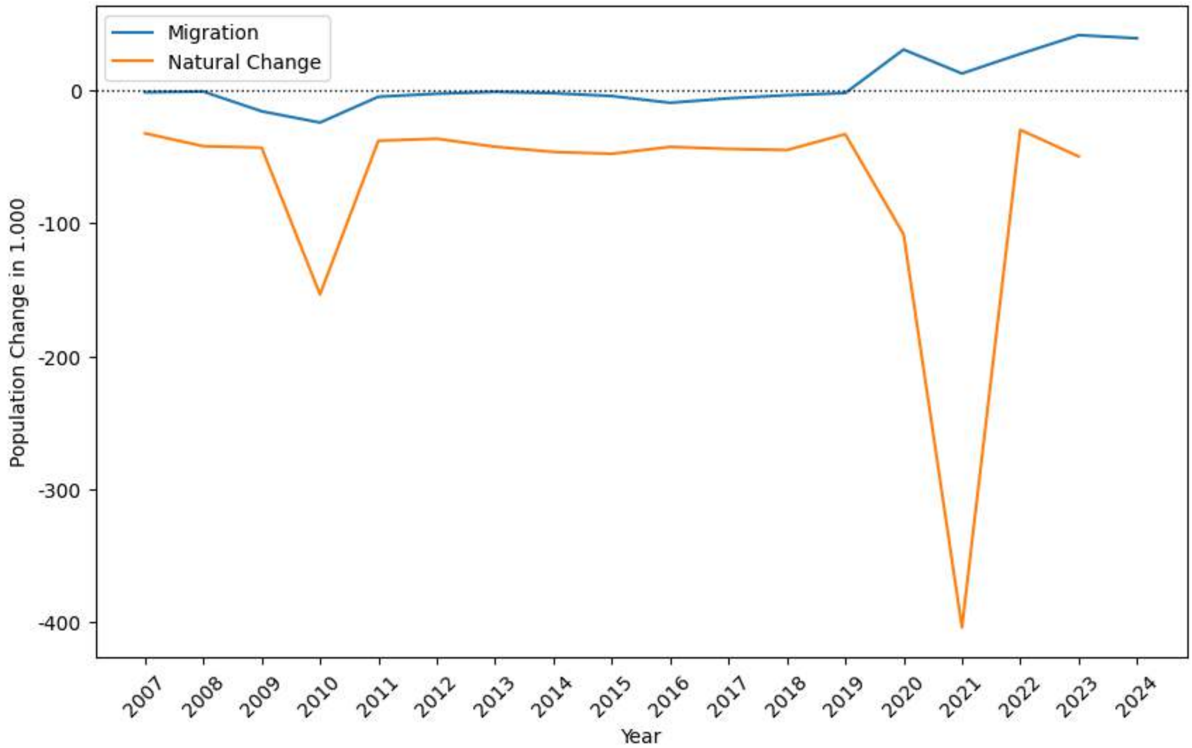

Figure 2, Population change due to migration and natural change (Source: Infostat NSI)

Between 1985 and 1992, Bulgaria's population decline was driven almost exclusively by net outmigration, primarily as a result of political transition, economic instability, and the mass emigration of ethnic minorities. In the following decades, however, natural population decrease emerged as the dominant factor. The contribution of net migration to overall population loss has steadily diminished: it accounted for 39% of the decline between 1992 and 2001, dropped to 31% during 2001–2011, and fell to below 10% from 2011 onward (*10 Years in EU: Migration Trends in Bulgaria*, 2017). This trend reflects a demographic shift in which low fertility rates and population aging have become the primary drivers of depopulation, surpassing the impact of migration.

Between 2010 and 2019, Bulgaria experienced a continuous population decline, primarily driven by negative natural population change, international migration barely played a role as seen in figure 2. Nonetheless, internal migration continued to reshape regional population dynamics during this period.

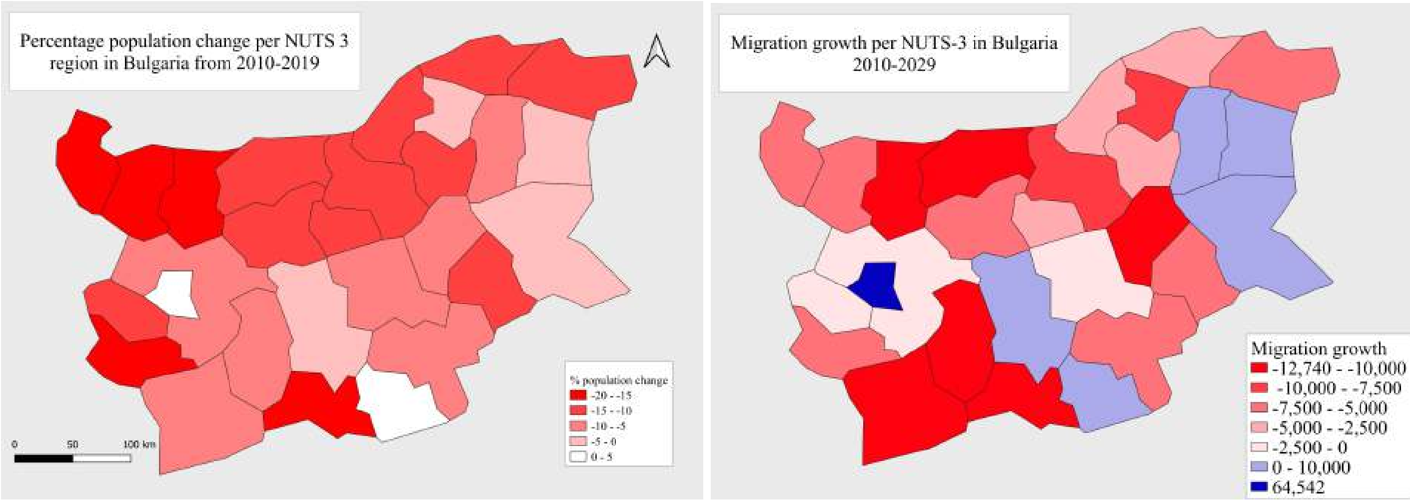

Figure 3, Population change and migration

Figure 3 illustrates the considerable spatial variation in population change and migration across Bulgaria between 2010 and 2019. While most regions experienced population decline, two saw population growth, indicating that depopulation is not a uniform national trend. Similarly, six regions recorded positive net migration despite overall population loss in most areas. Combined with the low levels of international migration shown in Figure 2, this suggests that internal migration between NUTS-3 regions remains highly active and regionally differentiated. Although natural population change is the primary driver of national depopulation, internal migration still plays a crucial role in shaping local demographic patterns and deserves focused research attention. The demographic context of Bulgaria, marked by sustained natural population decline rather than large-scale out-migration, is increasingly relevant for other European countries projected to face similar trends. Understanding how regional characteristics influence internal migration in such contexts offers valuable insight for managing population dynamics across Europe.

3 Model Framework

3.1 Two stage model framework

This study examines the role of natural characteristics in shaping migration patterns within Bulgaria at the NUTS-3 level during the period 2010–2019. To do so, it adopts a two-step regression framework that separates economic drivers from deeper, more structural non-economic influences such as geography, infrastructure, and social amenities.

In the first stage, a Fixed Effects (FE) model is employed to estimate the influence of regional GDP per capita levels on net migration rates (in percentage) across Bulgarian NUTS-3 regions from 2010 to 2019. Economic factors particularly income are widely recognized in the migration literature as key determinants of population movement. To isolate the economic component, the model includes both region

fixed effects (capturing time-invariant, unobservable regional characteristics) and year fixed effects (controlling for time-specific national shocks). This specification ensures that the estimated effect of income is not confounded by structural
regional traits or broader temporal influences.

The specification is as follows:

$$MigrationRate_{it} = \beta_1 ln(GDP/capita_{it}) + \gamma_t + \alpha_i + \varepsilon_{it}$$

Where:

- $MigrationRate_{it}$ is the net migration rate in percentage in region i at time t
- $ln(GDP/capita_{it})$ is the natural logarithm of average income per capita, capturing economic opportunity
- γ_t represents year specific coefficients
- α_i estimated region fixed effects (i.e., unobserved regional attractiveness)
- ε_{it} is the error term
- β_1 is the coefficient measuring the elasticity of migration with respect to income

Taking the logarithm of GDP/capita helps address potential skewness and the presence of outliers, and allows for interpretation in terms of percentage changes. Clustered standard errors are used.

The second stage consists of a cross-sectional OLS regression, where the estimated region fixed effects from the first stage serve as the dependent variable. This step aims to explain persistent interregional differences in migration that are not driven by income or national-level temporal shocks. Instead, it focuses on regional attributes related to nature, infrastructure and demographics. The selection of explanatory variables in the second-stage regression is informed by prior empirical research, particularly the meta-analyses conducted by Nishimura and Czaika (2023b) and Czaika and Reinprecht (2020), as well as the article by Simpson (2022). These studies collectively highlight a diverse range of migration determinants beyond economic factors most notably environmental, demographic, and infrastructural attributes which are particularly relevant when exploring long-term spatial differences in migration patterns.

The estimated region fixed effects from the first-stage regression are intended to capture time-invariant unobserved heterogeneity across regions. It is therefore essential that the explanatory variables in the second stage are also relatively time-invariant. Although variables such as environmental quality, demographic composition, and infrastructure may evolve over time, their rate of change is generally slow and gradual compared to economic indicators. Between 2010 and 2019, Bulgaria's GDP per capita increased significantly from approximately €5,100 to €9,300 representing an increase of over 80%. This substantial economic growth over the decade highlights the dynamic nature of economic drivers. This justifies the treatment of the non-economic variables as quasi time-invariant for the purposes of this analysis.

By applying this approach, the analysis aims to identify which structural, non-economic factors systematically influence migration across regions. While the use of OLS allows for straightforward interpretation, it also comes with limitations, including potential multicollinearity or omitted variable bias, which are acknowledged in the analysis and addressed where possible. Robust standard errors are used.

The specification of the second stage is as follows:

$$\alpha_i = \delta_1 Environmental_i + \delta_2 Demographic_i + \delta_3 Infrastructure_i + \eta_i$$

Where:

- α_i is the estimated region fixed effects from the first stage
- $Environmental_i$ is the environmental variables
- $Demographic_i$ is the demographic variables
- $Infrastructure_i$ is the indicators of accessibility and regional connectivity
- η_i is the error term
- δ_1, δ_2 and δ_3 are the coefficients measuring the effects of Nature, Demographic and Infrastructure variables on the region fixed effects

3.2 Strengths and limitations

A key strength of the Fixed Effects (FE) approach is its ability to control for unobserved heterogeneity across regions, thereby reducing the risk of omitted variable bias (Allison, 2009). By differencing out region-specific constants, the model isolates within-region variation over time. In this study, the estimated region fixed effects from the first stage are interpreted as capturing non-economic, time-invariant characteristics that influence migration patterns. These fixed effects are subsequently used as the dependent variable in a second-stage analysis aimed at explaining structural variation across regions.

The fixed effects methodology is well established in migration studies, with numerous variations employed. For instance, Etzo (2011) applies multiple fixed effects specifications, including standard FE, random effects, two-stage least squares FE, and the Fixed Effects Vector Decomposition (FEVD) model, to identify GDP per capita and unemployment as key drivers of interregional migration in Italy. Ashby (2010) uses fixed effects to examine the role of economic and political freedom in U.S. interstate migration, finding statistically significant effects. Ortega and Peri (2009) also include fixed effects in international panel models of migration to account for country-specific heterogeneity. Additionally, multi-step approaches involving fixed effects estimation have been employed in related domains such as environmental migration (Feng & Oppenheimer, 2012).

However, the specific approach adopted in this paper, using estimated region fixed effects from a first-stage panel regression as the dependent variable in a second-stage cross-sectional analysis, has not yet been applied in migration research. This method is discussed in econometric textbooks (Hsiao, 2022) and has been employed in other fields of economic research. For example, Olson et al. (2000) first regress the growth rate of output on labor and capital growth while including country fixed effects, and then use the estimated fixed effects in a second-stage regression to examine the impact of institutional quality. This two-step approach allows researchers to isolate the influence of relatively stable, structural factors on long-term outcomes. In this study, a similar logic is applied to regional migration tendencies. Given the methodological novelty within the migration literature, several robustness checks are conducted and reported in Section 6 to assess the reliability and validity of the findings.

4 Data and Variable Selection

4.1 General data remarks

The analysis is conducted at the NUTS-3 regional level, primarily due to constraints in data availability. While migration data were accessible at the municipal level, income data were not consistently available below the NUTS-3 scale. To ensure consistency and avoid the *modifiable areal unit problem* (MAUP) a well-documented issue in spatial econometrics where results can vary depending on the scale or zoning of the spatial units this study adopts the NUTS-3 level for all variables. The variables are shown in table 1.

Table 1, Variable explanation

Variable name	**Variable explanation**
Migration rate	The migration rate in percentage per NUTS-3 region per year from 2010-2019
GDP per capita	The average GDP per capita per NUTS-3 region per year from 2010-2019
Percentage protected area	The percentage of the area of the NUTS-3 region being covered by protected area
Mean elevation	The mean elevation of the NUTS-3 region in meters
Population density	The population density per nuts 3 in persons per square kilometer
Natural logarithm of distance to Sofia	The natural logarithm of the euclidean distance from the NUTS-3 region to the capital Sofia in kilometers
Cooling degree days	The extent of cooling demand
Heating degree days	The extent of heating demand

Migration data are sourced from the National Statistical Institute of Bulgaria (Migration of the Population by Districts, Municipalities and Sex, n.d.), which reports migration flows at the district level, corresponding to NUTS-3 regions. To account for differences in population size across regions, the analysis employs the net migration rate in percentage rather than absolute migration figures. The migration rate is calculated by dividing the migration flow of each NUTS-3 region by its population size; to obtain it in percentage, it is multiplied by 100. This normalization allows for more meaningful comparisons across areas with varying population scales. The population data used to calculate the migration rate are obtained from Eurostat (Population Density by NUTS 3 Region, 2025).

Most of the data used in this study are sourced from the National Statistical Institute (NSI) of Bulgaria, which is the country's central authority for official statistics. The NSI operates under the Statistics Act, ensuring its professional independence and adherence to high standards. It coordinates with other national and European bodies to produce consistent and comparable data. Importantly, the NSI is certified under international standards for quality (ISO 9001) and data security (ISO 27001), which reflects a strong commitment to accuracy, transparency, and trustworthiness. These certifications mean that the institute follows internationally recognized procedures to ensure the data it produces is reliable, well-managed, and fit for research purposes ("Peer Review Report," 2022).

4.2 Economic variables

Economic indicators are widely recognized as primary drivers of migration (Nishimura & Czaika, 2023), with previous research frequently incorporating measures such as absolute and relative income, GDP per capita, unemployment rates, job availability, labor market conditions, poverty levels, income inequality (e.g., Gini index), and cost of living. This study uses GDP per capita as the core economic indicator, given its broad availability across regions and straightforward interpretability. The data are obtained from Eurostat (Gross Domestic Product (GDP) at Current Market Prices by NUTS 3 Region, 2025). To avoid issues of multicollinearity, only one economic variable GDP per capita is included in the model. Although additional variables such as unemployment or job vacancy rates might offer further insights, their high correlation with GDP per capita could obscure individual effects and compromise model stability.

4.3 Environmental variables

Natural and environmental features can make regions more or less attractive to live in. This section discusses how nature, elevation, and climate are used to reflect environmental quality and comfort across regions.

Hjerpe et al. (2020) conducted an econometric analysis of migration patterns across rural counties in the Western United States from 1980 to 2010, identifying natural amenities particularly protected public lands such as Wilderness and National Monuments as key positive drivers of migration. Their findings support the use of natural land coverage as a proxy for nature-based attractiveness. Based on this, the percentage of protected natural area per NUTS-3 region is used in this study as a measurable and interpretable indicator of nature. The natural sites considered in this study comprise areas designated under the Natura 2000 network as well as nationally protected areas, as defined by the European Environment Agency (European Protected Sites, 2014; Natura 2000 – Spatial Data, 2022). The percentage of nature per NUTS-3 region is calculated using QGIS.

Elevation has also been studied as a potential determinant of migration patterns. Telbisz et al. (2020) highlight that higher-altitude settlements in western Serbia are experiencing more depopulation. The underlying rationale is that elevation often corresponds with reduced accessibility and more challenging living conditions, making such areas less attractive to residents. In contrast, Wang et al. (2024), examining older adult migration in China, interpret elevation as an environmental health factor. Their findings suggest that while altitude exerts a statistically significant influence on both inter- and intra-provincial migration, its explanatory power is relatively limited. These contrasting findings underscore the spatially contingent nature of elevation's role in migration and support the inclusion of elevation as a control variable in this study's analysis of the Bulgarian context.

Climate conditions, particularly temperature, are recognized as influential factors in migration decisions. Several studies identify temperature-related indicators as significant drivers, especially in contexts of rural depopulation and amenity migration. For instance, research on older adult migration in China finds that annual average temperature functions as a key environmental health determinant affecting both inter- and intra-provincial migration patterns (Wang et al., 2024). Similarly, studies of the American West show that warmer January temperatures are positively associated with net migration, while cool summer temperatures are viewed as a desirable amenity (Hjerpe et al., 2020). A particularly robust approach to operationalizing climate-related comfort is through Heating Degree Days (HDD) and Cooling Degree Days (CDD), as employed in econometric migration models by Baylis et al. (2024). Their research demonstrates a significant relationship between persistent temperature increases and long-term migration patterns in the United States over the past seventy years.

This study adopts HDD and CDD as proxies for climatic comfort, using data from Eurostat at the NUTS-3 level ("Cooling and Heating Degree Days by NUTS 3 Region – Annual Data," 2025). These indices capture the extent of heating and cooling demand, respectively, based on deviations from a reference indoor comfort temperature. HDD measures the demand for heating when daily mean temperatures fall below 15°C. For each such day, the difference between the reference indoor temperature of 18°C and the actual mean is calculated (e.g., a daily mean of 12°C yields an HDD value of 6). Similarly, CDD captures the demand for cooling when daily mean temperatures exceed 24°C, using a reference temperature of 22°C (e.g., a daily mean of 28°C results in a CDD value of 6). Lower values of both indices mean a milder, more comfortable climate, which is likely more attractive for settlement. To reduce the impact of annual fluctuations, this research uses the average HDD and CDD over the 2015–2024 period. This timeframe was selected based on data availability and provides a more stable representation of regional climate patterns than year-on-year figures.

4.4 Demographic variables

Demographic structure can shape migration flows by influencing the availability of services, population pressure, and social infrastructure, which in turn affect regional livability and appeal. Population density has been widely used in migration research as both a proxy for amenity availability and a structural factor influencing migration dynamics. Anjomani (2002) incorporates population density as an amenity-related variable when analyzing interstate migration in the United States. Similarly, Van Der Gaag and Van Wissen (2008) include population density as an explanatory variable in their cross-country study on in- and out-migration patterns in Sweden, the Netherlands, the United Kingdom, and Spain. In a more recent study focused on rural depopulation in mountainous regions of North Hebei Province, China, Yu et al. (2022) identify population density as a significant local push factor. The authors argue that lower densities are associated with reduced availability of social services such as education and essential public infrastructure which impacts depopulation. These findings reinforce the importance of population density as a structural indicator.

Population density was used instead of total population size to better capture the spatial intensity of human settlement. Unlike total population, density accounts for land area differences between regions and serves as a more consistent proxy for urbanization, a factor that can shape migration behavior. Population density is measured at the start of the analysis period (2010) to ensure temporal precedence and reduce potential endogeneity. This baseline value captures the structural settlement pattern prior to the observed migration flows, thereby serving as a consistent proxy for urbanization, accessibility, and public service availability that influence migration decisions (Population Density by NUTS 3 Region, 2025).

4.5 Infrastructure variables

The availability of key services and the accessibility of major urban centers influence regional living conditions and can shape migration decisions. Distance to the capital city serves as a control variable in this context, as it proxies accessibility to services and economic opportunities. Sofia, the national capital, hosts the country's main airport and is the only city with a population exceeding one million inhabitants; the next largest city, Plovdiv, has approximately 340,000 residents (Bulgaria Cities by Population 2025, n.d.). This urban hierarchy underscores Sofia's central role in national connectivity and service provision.

In studies of rural depopulation in Lithuania, distance to the capital city Vilnius has been shown to significantly influence migrant destination choices, with its importance increasing even in more remote municipalities, an indication of intensifying metropolization processes (Burneika et al., 2015). For this study, distance to Sofia in kilometers was calculated using NUTS-3 level shapefiles and Euclidean distance measures in QGIS, chosen for simplicity and consistency.

4.6 Descriptive statistics

The descriptive statistics in Table 2 highlight substantial variation in GDP per capita across NUTS-3 regions. This wide range reflects both the strong national economic growth between 2010 and 2019 and pronounced spatial disparities in regional development. Another notable observation is the variation in heating and cooling degree days across regions. Despite Bulgaria's modest size (approximately 111,000 square kilometers), there is significant climatic heterogeneity, which is likely due to the country's diverse topography. Similarly, the percentage of protected natural areas shows considerable variation, indicating uneven distribution of environmental amenities across the territory.

Table 2, descriptive statistics

Variables	Count	Mean	Std	Min	Max
Cooling degree days	28	201	85	27	377
Heating degree days	28	2,332	286	1,780	3,050
Mean elevation (m)	28	458	311	126	1,163
Distance to the capital (km)	28	144	99	0	332
GDP per capita	280	4,949	2,458	2,500	21,000
Migration rate (% per year)	280	-0.28	0.47	-1.48	3.75
percentage nature	28	0.39	0.13	0.10	0.59

Figure 4 presents the spatial distribution of the key explanatory variables across Bulgarian NUTS-3 regions. GDP per capita exhibits strong spatial variation, with the highest values concentrated in Sofia (the capital) and relatively elevated levels along the Black Sea coast. Net migration rates also show substantial regional variation. Some areas with high GDP per capita—particularly in the southwest and coastal regions—also experience positive net migration, while the northern part of the country stands out with consistently low or negative migration rates. The percentage of protected areas likewise displays marked spatial heterogeneity, with some regions having up to five times more protected land than others. Notable clusters of high protection levels are observed in the southwest and northeast, whereas the north and northwest tend to have significantly lower shares of protected area.

Four regions stand out for their distinct profiles: First, Sofia (capital) exhibits both exceptionally high GDP per capita and migration growth. Secondly, Stara Zagora and Gabrovo (located in the central region of Bulgaria) have high GDP per capita but experiences net out-migration, along with relatively low levels of protected area, suggesting that its economic strength does not translate into broader migrational attractiveness. And thirdly, Kardzhali (located in the central south) represents an anomaly, with higher-than-expected migration growth given its relatively low income level.

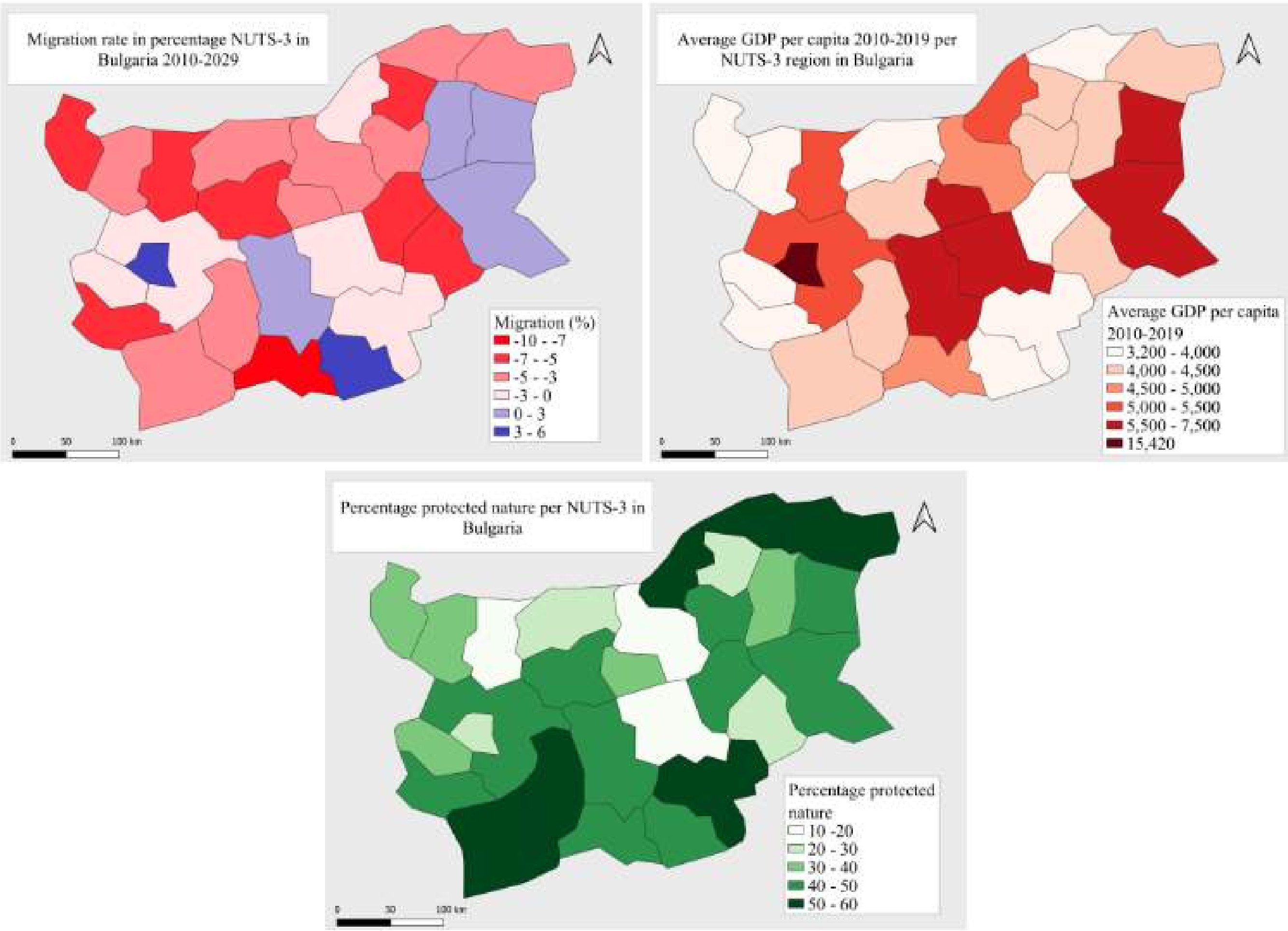

Figure 4, Descriptive maps

5 Results

The Pearson correlation matrix (Table 3) reveals several important relationships. Notably, distance to Sofia is strongly correlated with multiple other variables. Heating and cooling degree days (HDD and CDD) are also highly correlated with each other and due to hdd showing a stronger correlation with the region fixed effects, cdd is not used in the final model. Hdd and cdd also show strong associations with mean elevation and distance to Sofia, pointing to a shared climatic and topographic dimension. In contrast, the percentage of protected area exhibits low correlation with other variables, supporting its inclusion as an independent explanatory variable in the second-stage regression. This low correlation also reduces concerns of multicollinearity and enhances the interpretability of its coefficient.

Table 3, pearson correlation matrix

Variables	Region fixed effects	percentage protected nature	mean elevation	natural logarithm of distance to Sofia	population density	cooling degree days	heating degree days
Region fixed effects	1.00	0.30	-0.20	0.31	-0.29	0.20	-0.31
percentage protected nature	0.30	1	0.18	0.23	-0.17	-0.12	0.09
mean elevation	-0.20	0.18	1	-0.58	0.07	-0.79	0.72
natural logarithm of distance to Sofia	0.31	0.23	-0.58	1	-0.56	0.61	-0.58
population density	-0.29	-0.17	0.07	-0.56	1.00	-0.18	0.11
cooling degree days	0.20	-0.12	-0.77	0.61	-0.18	1	-0.92
heating degree days	-0.31	0.09	0.72	-0.58	0.11	-0.92	1

The first-stage regression results demonstrate statistically significant coefficients and overall model fit. As expected, GDP per capita has a positive effect on net migration rates. Specifically, a 1% increase in GDP per capita is associated with a 1.24 percentage increase in the migration rate. However, because the model's intercept is negative, this effect can be interpreted as a reduction in net out-migration, or put differently, an improvement in migration performance relative to regions with lower GDP per capita. This supports existing literature on the importance of economic opportunity in shaping internal migration.

Table 4, results fixed effects model first stage

Dep. Variable: Migration rate (%)	**Parameter**	**Std. Err.**	**T-stat**	**P-value**
Intercept	-10.70	5.78	-1.85	0.07
Natural logarithm of GDP per capita	1.24	0.69	1.80	0.07

F-test for Poolability: 12.77, P-value: 0.00, R-squared: 0.05, Included effects: Region, Time

Figure 5 presents the spatial distribution of the region fixed effects estimated in the first-stage Fixed Effects model. These values capture the time-invariant, non-economic characteristics of each region that systematically influence migration rates after accounting for GDP per capita. Regions shaded in purple exhibit negative fixed effects, meaning their migration rates are lower than expected based on their economic performance. For instance, a value of –0.34 indicates that the region's net migration rate is 0.34 percentage points lower than what would be predicted by GDP per capita alone. Conversely, regions with positive fixed effects experienced higher-than-expected migration rates.

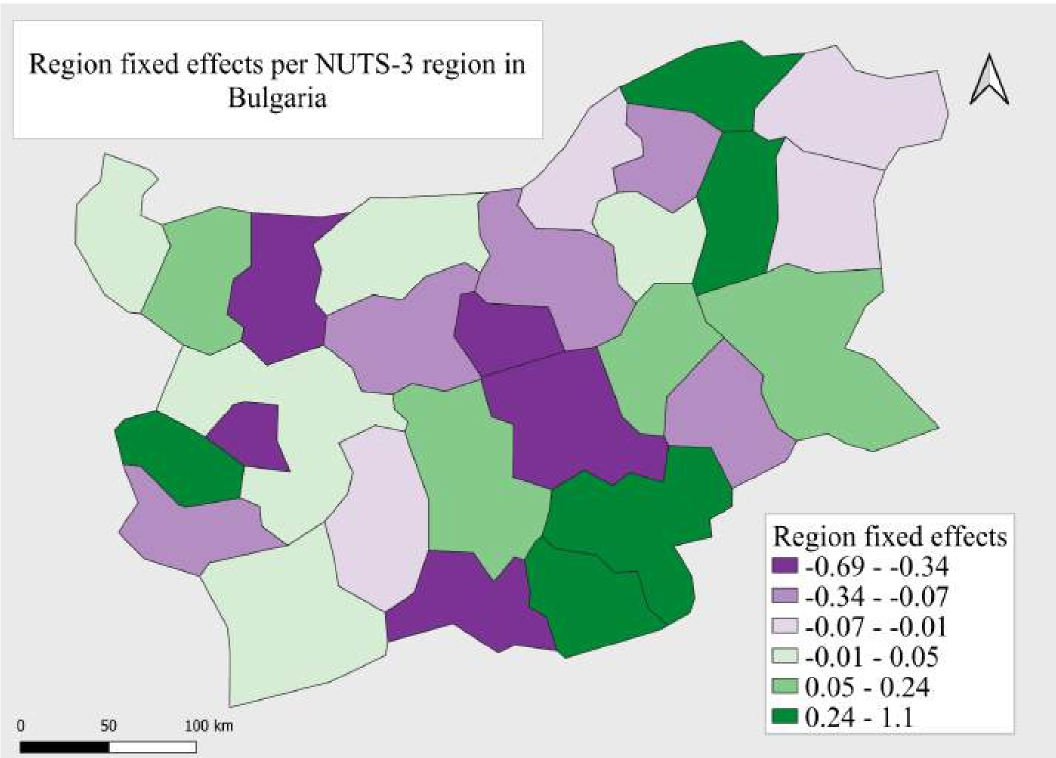

Figure 5, Region fixed effects

Table 5 presents the results of the second-stage OLS regressions, where the dependent variable is the region fixed effects estimated from the first stage. These fixed effects represent time-invariant, non-economic drivers of net migration across Bulgaria. The table shows 5 models where the ''Low correlation'' models contain the variables based on the Pearson correlation matrix.

Across all specifications, the percentage of protected natural areas emerges as a consistently significant and positive predictor. Its coefficient has a value between 0.0066 and 0.0093 in all models. The coefficients should be interpreted as a 1% increase in protected area is associated with an 0.0066 - 0.0093 percentage point increase in the region's expected migration rate, beyond what is explained by GDP per capita. Indicating that regions with more protected nature areas tend to have more favorable (less negative) fixed effects, that is, they are probably less unattractive to potential migrants after controlling for economic variables. However, it should be noted that the (adj.) R-squared of the nature model is low, indicating small explanatory powers of the model.

What stands out is the low p values of the variables in all the models except for percentage protected area and population density. Population density is significant and negatively associated with the dependent variable at the 5% level in the ''All variables'' and ''Low correlation'' models. In the ''low correlation'' models the independent variables have low multicollinearity based on the Pearson correlation matrix in table 3 and are econometrically the strongest models.

Table 5, results OLS regression second stage

Dep. Variable: region fixed effects from step1	Nature	Environment	Nature and control	Low correlation (elevation)	Low correlation (hdd)
constant	-0.34*	0.65	-0.16*	0.29	1.09*
percentage protected area	0.0085**	0.0093**	0.0066*	0.0087**	0.0083**
heating degree days		-0.44			-0.41
mean elevation				-0.0003	
natural logarithm of population density			-0.085**	-0.12**	-0.12**
natural logarithm of distance to Sofia			-0.052		
R-squared	0.09	0.21	0.17	0.22	0.25
R-squared Adj.	0.05	0.14	0.06	0.12	0.15

* p<.1, ** p<.05, ***p<.01

6 Robustness Checks

Given that the two-stage modeling approach used in this study, where estimated region fixed effects from a first-stage panel model are analyzed in a second-stage cross-sectional regression, is relatively novel in migration research, it is important to assess the reliability and stability of the findings. This section presents a series of robustness checks designed to test the sensitivity of the results to different model specifications, variable selections, and estimation strategies. These include alternative first-stage models, the addition of potentially relevant covariates, the use of lagged variables, and a baseline OLS regression for comparative purposes. Together, these checks help to validate the empirical strategy and provide greater confidence in the main results.

6.1 One stage OLS model

To complement the 2 stage fixed effects analysis, a baseline Ordinary Least Squares (OLS) regression is included as a robustness check. This approach is commonly used in migration research to provide a benchmark comparison, as seen in studies such as Ashby (2010) and Nyoni and Kollamparambil (2022). This model estimates the relationship between GDP per capita and migration without controlling for region- or year-specific effects. While OLS lacks the ability to account for unobserved heterogeneity, it provides a useful point of comparison for assessing the added value of the fixed effects specification.

By comparing the OLS results to those from the FE model, it is possible to evaluate whether the inclusion of fixed effects meaningfully alters the estimated relationships. A large discrepancy in coefficient size or significance may suggest that unobserved regional characteristics play an important role, validating the use of fixed effects. Conversely, similar results can help reassure that the core relationship (e.g., between income and migration) is robust to different modeling strategies.

The first one-stage OLS model (Table 7), which includes only the percentage of protected area as an explanatory variable, the results indicate no statistical significance and a very low R-squared, suggesting limited explanatory power when nature is considered in isolation. In contrast, the second model, which includes only GDP per capita, yields a coefficient with a p value of lower than 0.01. Introducing an interaction effect between GDP per capita and the percentage of protected area alters the results notably: the main effect of protected area turns negative and remains insignificant, while the interaction term becomes positive. This suggests that the positive effect of GDP per capita on migration is stronger in regions with a higher share of protected nature.

When all control variables are included in the model, the adjusted R-squared increases substantially to 0.49. Interestingly, GDP per capita becomes statistically insignificant, and the constant turns negative. This shift is likely due to the inclusion of highly significant environmental controls such as heating and cooling degree days, both of which show negative coefficients and strong significance, potentially absorbing some of the variation previously attributed to GDP per capita. The final model, which excludes the interaction term but includes other variables, still yields a relatively high R-squared. In this specification, population density appears to be a particularly important predictor of migration patterns and percentage protected area becomes positive and statistically significant.

Table 7, one stage OLS model

Dep. variable: migration rate 2010-2019	Nature	GDP per capita	Interaction	All variables	Low correlation
Const	-3.26*	-53.71***	-51.62*	26.37	-25.37
percentage protected area	0.012		-0.22	-1.15	0.056*
ln GDP per capita average		6.03***	5.55*	-3.09	2.03
ln GDP per capita average x percentage nature			0.032	0.14	
heating degree days				-5.4*	-3.71
ln Population density				2.56	2.91*
ln distance to the capital				-0.74	
R-squared	0.0018	0.27	0.3	0.49	0.47
R-squared Adj.	-0.037	0.24	0.22	0.35	0.37

* p<.1, ** p<.05, ***p<.01

6.2 First stage variable selection

Table 5 presents five variations of the first-stage fixed effects model to assess the robustness of the baseline specification; all the models include year and region effects. The first model serves as the reference model used in the main analysis with GDP per capita as the primary explanatory variable. In Model 2, GDP per capita is lagged by one year to account for potential decision-making delays, migrants may base their relocation choices on prior economic conditions rather than current ones. This specification tests whether income effects are temporally lagged in their influence on migration.

Model 3 introduces age dependency as an additional explanatory variable. Age-based demographic characteristics have been identified as important determinants of migration in previous research (Nishimura & Czaika, 2023), and in Bulgaria, demographic shifts have occurred rapidly during the study period. Including this variable in the first-stage model (rather than the second-stage) captures time-varying demographic effects that may directly influence annual migration flows. Model 4 tests the inclusion of population density. This variable reflects spatial structure and urbanization, which may influence migration directly by capturing crowding, infrastructure availability, or job agglomeration effects. However, there is also a risk of reverse causality, as migration flows themselves impact population density. To account for this, Model 5 incorporates a one-year lagged version of population density to reduce simultaneity concerns. Together, these variations provide insight into the stability of the estimated region fixed effects across different specifications and help to ensure that the two-step modeling approach is not overly sensitive to specific variable choices.

The primary variable of interest GDP per capita shows consistent values and consistent statistical significance except for in the last model. In contrast, additional control variables such as population density, lagged income, and the age dependency ratio generally failed to reach significance. Although the models that included population density exhibited slightly higher R-squared values and F-statistics, the low statistical significance of these variables suggests limited explanatory power. Therefore, the model including only GDP per capita was selected as the preferred specification for the first stage.

Table 5, variations on first stage fixed effects

Dep. Variable: Migration rate (%)	Only GDP per capita	Lagged GDP per capita	GDP per capita + age dependency	GDP per capita + population density	GDP per capita + lagged population density
Intercept	-10.7(5.8)	-1.6(3.0)	-11.2	-27.6(18.5)	-27.3(17.2)
Natural logarithm of GDP per capita	1.2*(0.7)		1.2*(0.7)	1.3*(0.7)	1.2(0.8)
Lagged natural logarithm of GDP per capita		0.2(0.4)			
Age dependency ratio			0.0(0.0)		
Natural logarithm of population density				4.1(3.5)	
Lagged natural logarithm of population density					4.3(2.9)
R-squared	0.05	0.00	0.05	0.13	0.12
F-stat	12.78	0.20	6.45	17.87	14.25
No. Obs.	280	252	280	280	252

Included effects: Region, Time, * p<.1, ** p<.05, ***p<.01

6.3 LSDV model

To assess the robustness of the first-stage fixed effects estimation, an alternative specification using the Least Squares Dummy Variable (LSDV) approach was estimated. Lakshmanasamy (2021) also examined both the fixed effects model and the Least Squares Dummy Variable (LSDV) model in the context of migration research. Their study investigated the determinants of international migration in OECD countries using panel data. Unlike the within transformation used in the standard fixed effects model, the LSDV method includes an explicit dummy variable for each region. The Least Squares Dummy Variable (LSDV) regression results (Table 6) are largely consistent with the fixed effects models in terms of the direction and magnitude of the coefficients. However, there are two key differences. First, the coefficients in the LSDV models are more statistically significant. Second, the F-statistics are higher. The high R^2 from the LSDV specification reflects GDP per capita’s strong explanatory power in accounting for spatial differences in net migration.

Table 6, first stage LSDV results

Dep. Variable: Migration rate (%)	Only GDP per capita	Lagged GDP per capita	GDP per capita + age dependency	GDP per capita + population density	GDP per capita + lagged population density
Intercept	-10.7**	-1.6	-11.1**	-27.3**	-24.1**
Natural logarithm of GDP per capita	1.2**		1.2**	1.3**	1.2*
Lagged natural logarithm of GDP per capita		0.2			
Age Dependency Ratio			0		
Natural logarithm of population density				4.1*	
Lagged natural logarithm of population density					4.3**
R-squared	0.66	0.63	0.66	0.69	0.67
Adj. R-squared	0.61	0.57	0.61	0.64	0.62
F-statistic	25.54	75.27	26.01	25.55	83.23

Included effects: Region, Time, * p<.1, ** p<.05, ***p<.01

6.4 Random effects model

A random effects model was also estimated, consistent with prior research on migration and panel data that primarily focuses on fixed effects models (Lakshmanasamy, 2021; Mihi-Ramírez et al., 2017). The random effects model is uniquely capable of integrating time-varying panel data—such as migration rates, GDP per capita, and population density—with time-invariant factors, including the percentage of natural land and heating degree days. However, this model has certain limitations. It assumes that unobserved individual effects are uncorrelated with the explanatory variables, an assumption that, if violated, can lead to biased and inconsistent estimates. Additionally, the random effects model may be less robust to omitted variable bias compared to fixed effects approaches. Despite these limitations, the model remains valuable as it allows for the inclusion of both time-varying and time-invariant variables, providing a more comprehensive analysis when such factors are relevant to the research question.

The results of the random effects model (Table 7) indicate that GDP per capita has a positive and statistically significant effect, though the coefficient is approximately half the magnitude found in other models. The percentage of natural land exhibits a coefficient of 0.0074, closely aligning with the 0.0066 to 0.0093 range observed in the two-stage model, and is statistically significant at the 0.05 level. Population density does not reach statistical significance, with coefficient values falling between those of the alternative models. Heating degree days are statistically significant and yield a coefficient identical to that in the two-stage model. Specifically, an increase of one thousand heating degree days is associated with a decrease in the migration rate of 0.4 percentage points.

Table 7, random effects model results

Dep. Variable: Migration rate (%)	Paramete r	Std. Err.	T-stat	P-value
Intercept	-6.21	1.57	-3.96	0.001
Natural logarithm of GDP per capita	0.68	0.24	2.88	0.0042
percentage nature	0.0074	0.0036	2.07	0.039
Natural logarithm of population density	0.16	0.11	1.41	0.16
Heating degree days	-0.4	0.2	-1.65	0.099

F-statistic (robust): 14.78, P-value: 0.00, R-squared (Overall): 0.32, Included effects: Time

6.5 Excluded variables

Several alternative variables were considered during the exploratory phase of the analysis but were ultimately excluded from the final model due to their low correlation with the region fixed effects. Table 8 presents a Pearson correlation matrix illustrating the relationship between these excluded variables and the estimated fixed effects.

As a demographic control, the percentage of the population aged 15–64 years (in 2010) was tested, but it showed only a weak correlation with migration-related region fixed effects. Indicators of infrastructure and urban amenities, such as the number of cinemas per 100,000 inhabitants and the natural logarithm of museum area per 10,000 inhabitants, were also evaluated. The rationale behind these variables is that a greater cultural offering might increase the attractiveness of a region. However, their correlation with the fixed effects was found to be low.

In addition, categorical variables provided by Eurostat—such as rural, coastal, and mountain region dummies—were examined. These indicate whether a region is predominantly rural, has direct coastal access, or is characterized by a predominantly mountainous population distribution. None of these dummy variables demonstrated a strong relationship with the region fixed effects. Finally, elevation range was considered as an alternative geographic measure to mean elevation, but it did not show higher explanatory potential.

Table 8, Pearson correlation matrix of low correlation variables

Variables	Region fixed effects	Percentage of population aged 15-64 years(2010)	cinemas per 100k	ln museum area per 10k	rural dummy	coastal dummy	mountain dummy	elevation range
Region fixed effects	1.00	0.06	0.01	0.00	0.10	0.05	0.09	0.20
Percentage of population aged 15-64 years(2010)	0.06	1.00	0.01	0.27	0.04	0.28	0.10	0.17
cinemas per 100k	0.01	0.01	1.00	0.15	0.12	0.26	0.25	0.01
ln museum area per 10k	0.00	0.27	0.15	1.00	0.12	0.23	0.01	0.17
rural dummy	0.10	0.04	0.12	0.12	1.00	0.18	0.04	0.05
coastal dummy	0.05	0.28	0.26	0.23	0.18	1.00	0.32	0.36
mountain dummy	0.09	0.10	0.25	0.01	0.04	0.32	1.00	0.74
elevation range	0.20	0.17	0.01	0.17	0.05	0.36	0.74	1.00

7 Conclusion

This study investigates how environment and nature influence migration patterns in Bulgaria between 2010 and 2019. By employing a two-stage regression framework, it isolates persistent regional characteristics from economic fluctuations, allowing a clearer view of how non-economic drivers, particularly nature-related factors, affect migration outcomes over time.

The results indicate that regions with greater shares of protected natural areas and more comfortable temperatures tend to experience slightly less out-migration, a 10 percent increase in protected nature is associated with an 0.079 - 0.096 percentage point increase in the region's expected migration rate, beyond what is explained by GDP per capita. This may suggest that natural amenities play a small but meaningful role in enhancing regional attractiveness and retaining population, even in the face of broader economic disparities. While economic performance (as proxied by GDP per capita) is most important, these findings highlight that people are also influenced by the long-term livability and environmental quality of a region.

Importantly, while the study cannot establish definitive causation, the consistent and statistically significant associations point to a high probability of a meaningful relationship between the percentage of protected area and migration outcomes. These patterns offer a compelling direction for further research and policy development, particularly in the context of regions facing depopulation.

The implications extend beyond Bulgaria. As many European countries prepare for future demographic decline, the potential to reduce out-migration through environmental and spatial policy offers a promising, underexplored avenue. Investing in the preservation and promotion of natural amenities may be a viable strategy to enhance regional resilience not just economically, but also socially and demographically.

While the findings of this study offer valuable insights into the relationship between nature and migration patterns, their direct applicability to policy may be limited. However, the results highlight promising avenues for future research. In particular, more granular studies at smaller spatial scales and investigations that differentiate between types of natural environments could yield more actionable insights. Such refined analyses could support the development of targeted and effective policy interventions.

8 Discussion

The results of this study support a broad and growing body of research highlighting the importance of nature and natural amenities in shaping migration. Across many empirical studies in mainly the U.S. and few in Europe, features such as protected areas, climate, landscape diversity, and scenic qualities are consistently found to attract migrants.

Hjerpe et al. (2020) examine the influence of specific types of public lands and natural amenities on migration to rural counties in the American West between 1980 and 2010. They find that counties with National Monuments experienced a 2.88% increase in net migration, those with Wilderness Areas saw an 8% increase, and counties containing multiple types of protected areas recorded as much as 11% net in-migration over the 30-year period. Since both National Monuments and Wilderness Areas are categories of protected areas, their findings align closely with this study's focus. Although the magnitudes they report are larger than the results from this study, this difference may be explained by their longer time frame (30 years versus 10 years) and the specific geographic context of the American West. Their study also suggests that the size of the protected area is an important factor, which is not tested explicitly in this analysis.

Chi and Marcouiller (2010) investigate the role of natural amenities in explaining population change in Wisconsin from 1970 to 2000, while controlling for economic drivers. They found that the percentage of forest area positively influenced population growth, although the strength of this relationship varied across decades. This highlights the importance of temporal and regional context when interpreting amenity migration patterns, and suggests that effects may evolve over time or differ by state or region.

Waltert and Schläpfer (2010) conduct a meta-analysis of 71 peer-reviewed studies on landscape amenities and local economic development. Among the 46 hedonic pricing studies they reviewed, natural reserves and conservation areas showed the most consistently positive effects, with 9 out of 11 studies reporting significant and positive impacts. While their focus is primarily on property values rather than migration per se, their results underscore the broad importance of protected natural areas as valued landscape features that can shape human settlement patterns.

Finally, Rodríguez-Pose and Ketterer (2012) assess whether local amenities influence regional attractiveness for internal migrants within Europe, analyzing 133 regions between

1990 and 2006. Their models consistently show that the relative size and presence of nature conservation areas had large and statistically significant positive effects on regional migration rates. These findings support this study's results regarding the positive association between the percentage of protected area and net migration, and suggest that preferences for preserved landscapes may extend beyond the U.S. context to European settings as well.

While the results of this study provide valuable insights into the relationship between natural amenities and migration in Bulgaria, several methodological considerations and limitations should be noted.

First, this study uses data at the NUTS-3 regional level, which is the most granular spatial resolution available for the relevant variables. While migration decisions ultimately occur at the individual or household level, the use of regional aggregates is a common and practical approach in spatial migration studies. One potential concern is that individuals living near the borders of regions may experience amenities such as nature areas or services from adjacent regions, or may reside in one region while working in another. This could blur the region-specific effects of characteristics like the percentage of protected nature. However, such cross-border spillover effects are likely limited in scope. Bulgaria's NUTS-3 regions are relatively large and not densely urbanized, meaning that most individuals live and interact primarily within their own region, especially outside of major metropolitan areas. As such, while some level of spatial spillover may exist, it is unlikely to significantly bias the results or alter the overall patterns observed in the analysis.

Second, the two-stage approach introduces certain assumptions. In the first stage, only GDP per capita was used as a time-varying explanatory variable. This choice was deliberate: GDP per capita explained a large portion of the within-region variance in net migration, and including more time-varying variables would risk multicollinearity. While other variables such as the age dependency ratio were considered, they did not show significant explanatory power and were therefore excluded. The choice for a relatively simple model reflects a balance between theoretical relevance, collinearity, and interpretability. Nonetheless, a more complex model could incorporate a wider range of time-varying socio-economic or demographic controls to better capture migration dynamics.

Third, the second-stage regression regresses region-level fixed effects on time-invariant variables such as protected nature, elevation, and climate. This step assumes that these variables remain relatively stable over the 2010–2019 period. For environmental features like elevation or climate indicators (e.g., heating and cooling degree days), this assumption is clearly justified. The percentage of protected nature is also assumed to be largely static over this period, though in reality, protected area designations can shift slightly, and the public's perception or accessibility of these areas may evolve. However, major changes in the extent of protected land are rare within such a short time span. A more substantial concern may be that underlying environmental quality, accessibility, or degradation of natural areas is not fully captured by the static land classification data used.

Variables such as population density may exhibit more temporal variation, but these are generally less volatile than dynamic economic variables like income. Population density was included in the second-stage regression rather than the first to reduce the risk of reverse causality. In the first stage, including density could lead to endogeneity, since migration flows directly affect population levels and thus density. By contrast, in the second stage, density is treated as a relatively stable, structural characteristic of a region, helping to explain long-term differences in net migration captured by the region-specific fixed effects. This approach minimizes bias and allows for a more meaningful interpretation of density as a contextual factor rather than a potentially endogenous outcome.

It is also important to acknowledge that some economic activity may not be fully captured in official GDP or employment data, especially in less urbanized regions. Informal or hidden economies, which can be particularly prevalent in rural or peripheral areas, may contribute to local livelihoods and influence migration decisions. If such unobserved economic activity varies systematically across regions, this could bias the estimates of both the first- and second-stage models. For example, regions with extensive informal tourism or subsistence farming linked to natural amenities may appear economically weaker in official statistics than they are in practice, potentially underestimating their attractiveness to migrants.

Relatedly, while the fixed effects from the first-stage model are used as summary measures of long-term net migration tendencies, they still contain residual variation from omitted or unobserved time-varying factors. This means that the results of the second stage do not allow for strong causal claims, but rather suggest associative patterns that warrant further investigation. The results show highly plausible and statistically significant relationships, particularly for the percentage of protected nature, but they should be interpreted as indications of structural associations rather than proof of direct causality.

Lastly, while this research focuses on Bulgaria, the methodological framework and findings may have broader relevance. In particular, the observed link between environmental amenities and reduced out-migration suggests policy potential for other European countries where depopulation is a growing concern. However, several limitations constrain the generalizability of the findings. Bulgaria has only 28 NUTS-3 regions, which limits the statistical power and granularity of the analysis. Exploring similar relationships at a more localized spatial scale, if data were available at municipal or NUTS-4 levels, or in countries with a greater number of comparable subnational units could provide a more detailed and robust picture. Cross-national comparative studies could further test whether the relationship between protected nature and migration holds in different institutional and geographic contexts.

9 Sources

10 years in EU: Migration trends in Bulgaria. (2017, October 19). osis.bg. Retrieved June 19, 2025, from https://osis.bg/?p=392&utm_source=chatgpt.com&lang=en

Allison, P. (2009). Fixed Effects regression models. In *SAGE Publications, Inc. eBooks*. https://doi.org/10.4135/9781412993869

Anjomani, A. (2002). Regional growth and interstate migration. *Socio-Economic Planning Sciences*, *36*(4), 239–265. https://doi.org/10.1016/s0038-0121(02)00010-1

Ashby, N. J. (2010). Freedom and international migration. *Southern Economic Journal*, *77*(1), 49–62. https://doi.org/10.4284/sej.2010.77.1.49

Baylis, P., Bharadwaj, P., Mullins, J., & Obradovich, N. (2024). Climate and Migration in the United States. *SSRN*. https://doi.org/10.2139/ssrn.5054997

Bulgaria cities by population 2025. (n.d.). worldpopulationreview.com. https://worldpopulationreview.com/cities/bulgaria

Burneika, D., Daugirdas, V., & Ubarevičienė, R. (2015). Migration as a factor of development of the depopulating areas in East EU countries – The case of Lithuania. *Europa XXI*, *27*, 79–95. https://doi.org/10.7163/eu21.2014.27.6

Chi, G., & Marcouiller, D. W. (2010). Isolating the effect of natural amenities on population change at the local level. *Regional Studies*, *45*(4), 491–505. https://doi.org/10.1080/00343400903496394

Cooling and heating degree days by NUTS 3 region - annual data. (2025, March 28). Eurostat. Retrieved June 5, 2025, from https://ec.europa.eu/eurostat/databrowser/view/nrg_chddr2_a/default/table?lang=en&category=reg.reg_env.reg_nrg_chdd

COVID-19 deaths. (n.d.). NSI - National Statistical Institute. Retrieved June 19, 2025, from https://www.nsi.bg/en/statistical-data/236/764

Czaika, M., & Reinprecht, C. (2020, April 29). *Drivers of migration: A synthesis of knowledge*. Haiku. https://www.migrationinstitute.org/publications/drivers-of-migration-a-synthesis-of-knowledge

De oorzaken van migratie onderzoeken – Waarom migreren mensen? | Onderwerpen | Europees Parlement. (2020, February 7). Onderwerpen | Europees Parlement. https://www.europarl.europa.eu/topics/nl/article/20200624STO81906/de-oorzaken-van-migratie-onderzoeken-waarom-migreren-mensen

Energy statistics - cooling and heating degree days (nrg_chdd). (n.d.). https://ec.europa.eu/eurostat/cache/metadata/en/nrg_chdd_esms.htm

Etzo, I. (2011). THE DETERMINANTS OF THE RECENT INTERREGIONAL MIGRATION FLOWS IN ITALY: A PANEL DATA ANALYSIS*. *Journal of Regional Science*, *51*(5), 948–966. https://doi.org/10.1111/j.1467-9787.2011.00730.x

European protected sites. (2014, June 2). Arcgis. Retrieved May 16, 2025, from https://www.arcgis.com/home/item.html?id=bf553d7ea5a246708c834e029699f900

Fawcett, J. T. (1989). Networks, linkages, and migration systems. *International Migration Review*, *23*(3), 671. https://doi.org/10.2307/2546434

Feng, S., & Oppenheimer, M. (2012). Applying statistical models to the climate–migration relationship. *Proceedings of the National Academy of Sciences*, *109*(43). https://doi.org/10.1073/pnas.1212226109

Fihel, A., & Okólski, M. (2019). Population decline in the post-communist countries of the European Union. *Population & Societies*, *567*, 1–4. https://shs.cairn.info/journal-population-and-societies-2019-6-page-1?lang=en&tab=texte-integral

Gross domestic product (GDP) at current market prices by NUTS 3 region. (2025, March 12). Eurostat. Retrieved April 15, 2025, from https://ec.europa.eu/eurostat/databrowser/view/nama_10r_3gdp/default/table?lang=en

Hjerpe, E., Hussain, A., & Holmes, T. (2020). Amenity Migration and public lands: rise of the protected areas. *Environmental Management*, *66*(1), 56–71. https://doi.org/10.1007/s00267-020-01293-6

Hsiao, C. (2022). *Analysis of panel data* (4th ed.). Cambridge university press.

Infostat NSI. (n.d.). Retrieved June 8, 2025, from https://infostat.nsi.bg/infostat/pages/module.jsf?x_2=1

Ivanov, S., Savova, D., Terziev, T., Paunov, D., & Zheleva, V. (2023). IMPACT OF COVID-19 ON THE MECHANICAL DEMOGRAPHIC MIGRATION IN BULGARIA. *Trakia Journal of Sciences*, *21*(1), 305–310. https://doi.org/10.15547/tjs.2023.s.01.049

Jennissen, R. (2003). Economic determinants of net international migration in Western Europe. *European Journal of Population / Revue Européenne De Démographie*, *19*(2), 171–198. https://doi.org/10.1023/a:1023390917557

Journal of Migration History. (n.d.). Brill. Retrieved June 1, 2025, from https://brill-com.vu-nl.idm.oclc.org/view/journals/jmh/jmh-overview.xml

Lakshmanasamy, T. (2021). INTERNATIONAL MIGRATION IN OECD COUNTRIES: PANEL ECONOMETRIC ANALYSIS OF THE DETERMINANTS. *Journal of International Economics and Finance*, *1–2*, 81–98. https://www.esijournals.com/image/catalog/Journal%20Paper/JIEF/No%202%20(2021)/5_Lakshmanasamy.pdf

Langella, M., & Manning, A. (2021). *Income and the desire to migrate* (By Centre for Economic Performance, London School of Economics, London School of Economics and Political Science, London School of Economics, & Economic and Social Research Council). https://cep.lse.ac.uk/pubs/download/dp1794.pdf

Li, Y., Sangraula, P. P., & Shilpi, F. J. (2014). Voting with their feet? access to infrastructure and migration in Nepal. In *World Bank*. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/307471468288638894/voting-with-their-feet-access-to-infrastructure-and-migration-in-nepal

Liu, Z., Liu, S., Jin, H., & Qi, W. (2017). Rural population change in China: Spatial differences, driving forces and policy implications. *Journal of Rural Studies*, *51*, 189–197. https://doi.org/10.1016/j.jrurstud.2017.02.006

Migration of the population by districts, municipalities and sex. (n.d.). NSI - National Statistical Institute. Retrieved May 9, 2025, from https://www.nsi.bg/en/content/3060/migration-population-districts-municipalities-and-sex

Mihai, I., & Novo-Corti, I. (2020). Cultural distance and migration patterns in the EU: the Romanian case. *EUROPEAN RESEARCH STUDIES JOURNAL*, *XXIII*(Issue 3), 410–424. https://doi.org/10.35808/ersj/1646

Mihi-Ramírez, A., Kumpikaitė-Valiūnienė, V., & Cuenca-García, E. (2017). AN INCLUSIVE ANALYSIS OF DETERMINANTS OF INTERNATIONAL MIGRATION. THE CASE OF EUROPEAN RICH AND POOR COUNTRIES. *Technological and Economic Development of Economy*, *23*(4), 608–626. https://doi.org/10.3846/20294913.2017.1306726

Minority Rights Group. (2020, July 7). *5.1: Migration as a global phenomenon. | Covering migration*. Covering Migration. https://coveringmigration.com/learning_pages/migration-as-a-global-phenomenon/

Mladenov, C., Dimitrov, E., & Kazakov, B. (2008). L'évolution démographique de la Bulgarie au cours de la période de transition. *Méditerranée*, *110*, 117–123. https://doi.org/10.4000/mediterranee.550

Natura 2000 - Spatial data. (2022, November 29). European Environment Agency. Retrieved May 12, 2025, from https://www.eea.europa.eu/data-and-maps/data/natura-14/natura-2000-spatial-data

Natural amenities. (2025, May 8). U.S. Department of Agriculture. https://www.ers.usda.gov/topics/rural-economy-population/natural-amenities#:~:text=The%20natural%20amenities%20scale%2C%20based,largely%20treeless%20or%20extensively%20forested.

Nishimura, A. S., & Czaika, M. (2023). Exploring Migration Determinants: a Meta-Analysis of Migration Drivers and Estimates. *Journal of International Migration and Integration / Revue De L Integration Et De La Migration Internationale*, *25*(2), 621–643. https://doi.org/10.1007/s12134-023-01091-z

Nyoni, G., & Kollamparambil, U. (2022). Rural-urban migration and the well-being of the migrant-sending households: An impact evaluation study. *South African Journal of Economic and Management Sciences*, *25*(1). https://doi.org/10.4102/sajems.v25i1.4120

OECD Economics Department. (2021). Migration, Housing and Regional Disparities: A gravity model of inter-regional migration with an application to selected OECD countries. In *OECD*. Retrieved June 1, 2025, from https://www.oecd.org/en/publications/migration-housing-and-regional-disparities-a-gravity-model-of-inter-regional-migration-with-an-application-to-selected-oecd-countries_421bf4aa-en.html

Olson, M., Jr, Sarna, N., & Swamy, A. V. (2000). Governance and Growth: A Simple Hypothesis Explaining Cross-Country Differences in Productivity Growth. *Public Choice*, *102*(3/4), 341–364. https://doi.org/10.1023/a:1005067115159

Ortega, F., & Peri, G. (2009). The Causes and Effects of International Migrations: Evidence from OECD Countries 1980-2005. *National Bureau of Economic Research*. https://doi.org/10.3386/w14833

Peer review report: ON COMPLIANCE WITH THE EUROPEAN STATISTICS CODE OF PRACTICE AND FURTHER IMPROVEMENT AND DEVELOPMENT OF THE NATIONAL STATISTICAL SYSTEM. (2022). In *Eurostat*. European statistical system. https://ec.europa.eu/eurostat/documents/64157/13566711/Peer+review+Report+Bulgaria.pdf/3b6debad-50b3-ebce-187d-babbf99adc95?t=1668092890598

Population density by NUTS 3 region. (2025, April 2). Eurostat. Retrieved May 16, 2025, from https://ec.europa.eu/eurostat/databrowser/view/demo_r_d3dens$defaultview/default/table?lang=en

Population per physician and per dentist by statistical zones, statistical regions and districts. (n.d.). NSI - National Statistical Institute. Retrieved June 10, 2025, from https://www.nsi.bg/en/statistical-data/240/776

Population projections in the EU. (2023, March). Eurostat. Retrieved April 20, 2025, from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Population_projections_in_the_EU

Poutvaara, P. (2021). Population aging and migration. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3862239

Quality of life indicators. (2025, March). Eurostat. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Quality_of_life_indicators

Schaeffer, Y., & Dissart, J. (2017). Natural and Environmental Amenities: A review of Definitions, Measures and issues. *Ecological Economics*, *146*, 475–496. https://doi.org/10.1016/j.ecolecon.2017.12.001

Simpson, N. B. (2022). Demographic and economic determinants of migration. *IZA World of Labor*. https://doi.org/10.15185/izawol.373.v2

Social impact of emigration and Rural-Urban migration in Central and Eastern Europe. (2012). In *ec.europa.eu*. European Commission DG Employment, Social Affairs and Inclusion. Retrieved June 1, 2025, from https://ec.europa.eu/social/BlobServlet?docId=8837&langId=en

Telbisz, T., Brankov, J., & Ćalić, J. (2020). Topographic and lithologic controls behind mountain depopulation in Zlatibor District (Western Serbia). *Journal of Mountain Science*, *17*(2), 271–288. https://doi.org/10.1007/s11629-019-5861-5

Van Der Gaag, N., & Van Wissen, L. (2008). ECONOMIC DETERMINANTS OF INTERNAL MIGRATION RATES: A COMPARISON ACROSS FIVE EUROPEAN COUNTRIES. *Tijdschrift Voor Economische En Sociale Geografie*, *99*(2), 209–222. https://doi.org/10.1111/j.1467-9663.2008.00454.x

Voss, P. R., & Chi, G. (2006). Highways and Population change*. *Rural Sociology*, *71*(1), 33–58. https://doi.org/10.1526/003601106777789837

Wang, H., Gao, X., Liu, G., Wang, F., & Rosenberg, M. W. (2024). Environmental health, economy, and amenities interactively drive migration patterns among China's older people. *Frontiers in Public Health*, *12*. https://doi.org/10.3389/fpubh.2024.1354071

Winter, S. (2019). "It's the Economy, Stupid!": On the Relative Impact of Political and Economic Determinants on Migration. *Population Research and Policy Review*, *39*(2), 207–252. https://doi.org/10.1007/s11113-019-09529-y

World Bank Open Data. (n.d.). World Bank Open Data. https://data.worldbank.org/indicator/SP.POP.TOTL?locations=BG

Yu, Z., Zhang, H., Sun, P., & Guo, Y. (2022). The pattern and local push factors of rural depopulation in Less-Developed Areas: a case study in the mountains of North Hebei Province, China. *International Journal of Environmental Research and Public Health*, *19*(10), 5909. https://doi.org/10.3390/ijerph19105909

Zaiceva, A. (2014). The impact of aging on the scale of migration. *IZA World of Labor*. https://doi.org/10.15185/izawol.99

Zhang, L., Jin, Y., Shen, R., & Hui, E. (2024). Impact of accessibility on residential location choice: a case study of Hangzhou, China. *Journal of Urban Planning and Development*, *151*(1). https://doi.org/10.1061/jupddm.upeng-4991

Źróbek, S., Trojanek, M., Źróbek-Sokolnik, A., & Trojanek, R. (2015). The influence of environmental factors on property buyers' choice of residential location in Poland. *Guoji Zhengzhi Yanjiu*, *7*(3), 163–173. https://doi.org/10.14254/2071-8330.2015/8-3/13