

FERTILITY PATTERNS AND REGIONAL DISPARITIES IN ROMANIA: EVIDENCE FROM SPATIAL PANEL MODELS

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Abstract

Romania, like many other European Union countries, has been facing a persistent decline in fertility, raising significant demographic and socio-economic concerns. Understanding regional disparities is essential for developing effective demographic policies. This paper examines fertility differences across Romanian counties (NUTS 3) between 2013 and 2023, using spatial econometric and panel data approaches. Exploratory Spatial Data Analysis (ESDA) revealed clear regional patterns: the North-East and Central regions (especially Suceava, Botoșani, Bistrița-Năsăud, Harghita, and Mureș) consistently registered high fertility rates, forming high–high clusters, while the South-West and West regions (notably Gorj, Vâlcea, and Hunedoara) exhibited persistently low fertility, forming low–low clusters. The Moran's I index, calculated for each year, confirmed a significant positive spatial autocorrelation ($p < 0.01$) throughout the entire period, with a slight decline during 2020-2021, potentially reflecting the impact of the COVID-19 pandemic. The estimated SARAR model with fixed effects confirmed the spatial dependence of fertility across counties. Results indicate that regional macroeconomic wealth (GDP per capita) is not statistically significant, whereas higher female labour force participation positively impacts fertility. Conversely, a high reliance on social assistance, high crude emigration rates, and significant educational burdens depress birth rates, revealing complex socio-economic dynamics. These results indicate that fertility patterns are shaped not only by structural and cultural factors but also by spatial spillovers. The findings highlight the importance of incorporating spatial dependence into demographic research and support the design of targeted, region-specific policies to reduce fertility disparities in Romania.

Keywords: Fertility rate, Spatial panel model, Regional disparities, Romania, Demographic analysis

JEL Classification: J13, R23, C23, J11, J18

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1. Introduction

Fertility lies at the foundation of any population, making it a key subject in the analysis of demographic phenomena (Rotariu, 2015). The specialized literature highlights that economic, cultural, political, and demographic factors shape distinct fertility patterns across regions (Mureşan, 2008; Jemna & David, 2018).

Romania, like many other European Union member states, is facing a significant decline in fertility, a trend that has become one of the most important demographic challenges in recent decades (Gheţău, 2018; Andrei et al., 2022). To be able to intervene, decision-makers must understand the complex set of factors that shape fertility and design interventions accordingly (Voicu & Papuc, 2023).

Most fertility research in Romania relies on national-level data and concentrates primarily on broad economic determinants such as income, employment, and fiscal policies (Gheţău, 2018; Rotariu, 2015). Although these dimensions are important, they do not provide a complete picture of how fertility levels vary across regions and counties. As highlighted by Jemna and David (2018), significant disparities persist between urban and rural areas, as well as across historical regions, yet these variations are often analysed in isolation. This highlights the need for a comprehensive analysis that explicitly accounts for spatial heterogeneity and investigates its underlying drivers.

This paper proposes a multidimensional approach for analysing fertility in Romania, from economic, cultural and spatial dimensions. The fertility patterns are not homogeneous at national level, with significant variations not only between regions and counties, but also even at a finer level between residence environments, and these influences must be analysed to outline an overview of the demographic realities in contemporary Romania (Fent, et al., 2013).

Equally important is the role of social values: while other counties are anchored in traditional values, in others modernity redefines individual and family priorities (Sobotka, 2008; Vignoli, et al., 2020). In this sense, fertility analysis can reveal the subtle mechanisms by which culture shapes reproductive decisions.

The primary aim of this study is to provide a spatial-temporal analysis of fertility dynamics in Romania at the NUTS 3 level (counties) for the 2013-2023 period. Rather than relying on national aggregates, the analysis is structured around several clustering patterns. First, it seeks to map the spatial evolution and clustering of fertility. To address this objective, the analysis uses an Exploratory Spatial Data Analysis (ESDA), the Global Moran's I and Local Indicators of Spatial Association (LISA), identifying how high and low fertility clusters have emerged, persisted, or fragmented over the past decade. Second, it seeks to estimate the socio-economic determinants using refined rates. The study assesses the impact of GDP per capita, social assistance dependency, female labour market participation, emigration rate, and educational investments on regional fertility. Finally, the study addresses spatial dependency in econometric modelling. The research identifies the most appropriate specification for capturing both endogenous interactions effects and spatially correlated unobserved factors. Taken together, these steps allow the paper to answer to what extent female employment serves as a stabilizer for regional birth rates.

To achieve these goals, the paper is structured as follows: Section 2 reviews the existing literature on fertility determinants in Romania, combining demographic perspectives and recent studies by local authors who have applied spatial models to social phenomena. Section 3 outlines the spatial econometric methodology and data, including the construction of the panel dataset, the definition of the variables, and the SARAR model specification; Section 4 presents the results and discussion, beginning with an exploratory analysis of Moran's I dynamics and LISA cluster maps, and continuing with the estimation results from OLS, SAR, SEM, and SARAR models; and Section 5 concludes with the main results, the study's limitations and policy recommendations.

2. Literature review

In Romania, regional disparities in fertility stem from a wide range of determinants, including the level of economic development, employment opportunities, educational attainment, and the intensity of migration flows of each area (Jemna & David, 2018; Goschin 2015). Furthermore, recent empirical studies underscore the necessity of moving beyond traditional linear models when assessing these social determinants. Local researchers have increasingly applied spatial econometrics to demonstrate that regional socio-economic phenomena and demographic behaviours do not act in isolation but are subject to significant spatial

spillover effects across neighbouring counties (Jaba et al., 2020; Andrei et al., 2022). This section synthesizes the main findings from the literature, emphasizing how these structural differences influence birth rates and providing a conceptual framework for understanding the regional variability of fertility in Romania.

Economic performance plays a central role in shaping reproductive behaviour, particularly regarding the postponement of childbirth. A favourable economic climate appears essential for this trend: Romania's 172% economic expansion from 1990 to 2010 was associated with an increase in the average age at first birth by 1.5 years. (Billingsley & Duntava, 2015)

A study by Jemna and David (2018) identified two categories of regions after 1995, differentiated by fertility changes relative to the national average. The regions with a downward trend, such as the North-East, South-East, South-Muntenia, South-West Oltenia and North-West, recorded more significant decreases in fertility, while the Bucharest-Ilfov, Centre and West regions had a slight increase in this indicator. Their fixed-effect models show that regional fertility variations are explained by changes in women's employment rate, marriage rate, urbanization, and real GDP per capita. Additionally, the divorce rate significantly influenced fertility in region-specific models, while the average age at first birth became a key factor in explaining fertility variation over time. Unemployment, on the other hand, did not appear as a significant predictor in any of the estimated models. The postponement of the birth of the first child remains an important feature in the countries of Central and Eastern Europe, especially in the post-communist transition period.

Romania increasingly reflects certain Western values, such as prioritising education and career development among young women, the perception that a teenage pregnancy as a major impediment in personal advancement, and the ideal of a two-child family. A shift away from traditional Eastern values is also visible in changing attitudes towards marriage, with Romanians increasingly opting to delay this step for their late twenties, a sign of a social transformation that advances slowly and unevenly (Preda, et al., 2020).

A review of the demographic literature shows that most studies examine fertility and employment separately, without integrating the two into a unified analytical framework (Fent et al., 2013). While numerous works explore the general economic and social determinants of fertility, few investigate the direct relationship between women's labour market participation and childbearing decisions at the regional level in Romania (Voicu & Papuc, 2023). Furthermore, as suggested by recent literature, understanding these social determinants requires moving beyond traditional models. Local authors have successfully demonstrated that applying spatial models to socio-economic indicators reveals strong interdependence between Romanian counties (Goschin, 2015; Jaba et al., 2020). Integrating these spatial methods to address the aforementioned gap raises important questions: how do regional economic insecurity, job flexibility, or parental support policies influence decisions about family formation, and how do these decisions spill over into neighbouring areas?

Another essential aspect that requires further research is the influence of the level of education on fertility. It is well known that women with a higher level of education tend to have fewer children, but the impact of each level of education – high school, college, postgraduate studies – on the birth rate is less explored. In Romania, where access to higher education varies significantly from one region to another, it is important to analyse to what extent these differences influence the decision to have children. For example, women with university education in urban areas may postpone motherhood for professional reasons, while in rural areas, where the participation rate in higher education is lower, the birth rate is influenced more by cultural norms than by economic factors (Jungho, 2023).

3. Methodology

Understanding fertility dynamics requires analytical tools that can capture both temporal developments and spatial relationships in reproductive behaviour. To ensure the robustness of the empirical analysis and eliminate size-induced distortions, all independent variables initially collected as absolute frequencies were transformed into relevant demographic and economic rates. Specifically, the analysis investigates the relationship between county-level fertility rates and the following set of variables: Gross Domestic (GDP) per capita, the rate of families receiving social assistance (per 1000 inhabitants), the female activity rate (active females as a percentage of the total female population), the crude emigration rate (per 1000 inhabitants), and the school enrolment rate (children and students in pre-university education per 1000 inhabitants).

The data were obtained from the TEMPO Online database (National Institute of Statistics), from which fertility indicators and county-level socioeconomic variables were extracted for the 2013–2023 time series. All indicators were harmonized and structured as a balanced panel dataset at the county level (NUTS 3).

The detailed definitions and the theoretical relevance of these constructed variables are summarised in Table no. 1.

Table no. 1: Description of variables

Variable	Definition	Relevance for fertility
GDP per capita	County-level Gross Domestic Product divided by the resident population	Shows the economic situation of the region; wealthier regions may influence family planning decisions
Social assistance rate	Number of families receiving minimum guaranteed income per 1000 inhabitants	Measures poverty and social support; economic stress can affect decisions to have children
Female activity rate	Active females as percentage of the total female population	Indicates women's participation in work, which can impact timing and number of children
Crude emigration rate	Number of permanent emigrants per 1000 inhabitants	Reflects population loss and potential reduction in reproductive-age individuals
School enrolment rate	Number of children and students in pre-university education per 1000 inhabitants	Shows the number of young people in the area; may reflect family size trends

Source: National Institute of Statistics, 2025

For the spatial analyses, Queen contiguity spatial weights matrices (order I) were constructed based on county administrative boundaries. These matrices allow the identification of spatial relationships and the estimation of spatial dependence across neighbouring counties (Anselin, 1988).

Given the multidimensional nature of fertility determinants, the methodology combines descriptive spatial tools, classical regression techniques, and advanced spatial econometric models.

Spatial autocorrelation was assessed using Moran's I, a global indicator that measures the overall degree to which similar values cluster across geographic units. A positive Moran's I suggests spatial clustering of similar observations, while a negative value indicates spatial dispersion (Moran, 1950). To explore local patterns, the analysis also employed Local Indicators of Spatial Association (LISA), which identify specific clusters, such as high–high or low–low areas, as well as spatial outliers at the local level (Anselin, 1995). These complementary measures allow both a global and local understanding of spatial structure in the variables under study.

Regarding the econometric strategy, we followed a structured and comprehensive model selection process, moving step by step from simpler to more complex spatial specifications. This approach was guided by the “general-to-specific” and “specific-to-general” framework proposed by Elhorst (2014).

We began with a non-spatial panel model, including county fixed effects to control for unobserved, time-invariant heterogeneity across regions. The choice for the fixed effects specification over random effects was supported by the Hausman test.

Next, we tested for the spatial dependence in the residuals of the baseline non-spatial model using both standard and robust Lagrange Multiplier (LM) tests. These diagnostics allowed us to assess whether a Spatial Autoregressive (SAR) model or a Spatial Error Model (SEM) would be more suitable.

To ensure a careful specification of the spatial structure, the Spatial Durbin Model (SDM) was also estimated as a more general benchmark model. The diagnostics and joint tests associated with the SDM were then examined to assess whether the model could be simplified to a SAR specification (which captures spatial spillovers through the dependent variable) or to a SEM specification (which models spatial dependence in the error term).

The diagnostic results indicated significant spatial autocorrelation both in the dependent variable and in the residual structure. Based on these findings, a Spatial Autoregressive Model with Autoregressive Disturbances (SARAR) with fixed effects was selected as the final specification. The SARAR model captured both endogenous interaction effects (where fertility outcomes in one county are influenced by neighbouring counties) and spatial correlation in unobserved factors, therefore providing a robust framework for modelling complex spatial spillovers in regional fertility dynamics.

The estimated model is expressed as follows:

$$y_{it} = \rho \sum_j w_{ij} y_{jt} + \beta X_{it} + \mu_i + u_{it} \quad (1)$$

$$u_{it} = \lambda \sum_j w_{ij} u_{jt} + \varepsilon_{it} \quad (2)$$

where:

- y_{it} is the dependent variable for unit i at time t (fertility rate),
- ρ is the spatial autocorrelation coefficient of the dependent variable,
- w_{ij} is the element in the spatial weights matrix W , which reflects the vicinity between units i and j ,
- β is the vector of the regression coefficients,
- X_{it} is the vector of explanatory variables (GDP per capita, social assistance rate, female activity rate, crude emigration rate, and school enrolment rate),
- μ_i is the autocorrelated spatial error term,
- λ is the spatial autocorrelation coefficient of errors,
- ε_{it} is the random component.

All data processing, spatial analyses, and visualisations were performed using Python.

4. Results and Discussions

Analysing fertility dynamics is essential for understanding reproductive behaviour, as it enables the identification of both temporal trends and spatial patterns in birth rates. In this study, fertility rates at the county level are examined in relation to several key explanatory variables, including the Gross Domestic Product (GDP) per capita, the social assistance rate, the female activity rate, the crude emigration rate, and the school enrolment rate. By applying spatial panel models over the period 2013-2023, this approach allows for a multidimensional assessment of fertility, providing a foundation for designing targeted public policies aimed at supporting fertility growth.

Panel data models are particularly suitable for this analysis because they combine observations over time and across spatial units, allowing researchers to account for individual heterogeneity, control for unobserved time-invariant factors, and improve the efficiency of parameter estimates (Baltagi, 2005).

4.1. Exploratory Spatial Data Analysis and Fertility Clustering

As an initial step, an exploratory spatial analysis was conducted by mapping the average fertility rate by county over the study period. The results indicate that Suceava County consistently recorded the highest average fertility, with the broader North-East region exhibiting generally higher values. In contrast, the South-West region, along with several counties in Muntenia and Dobrogea, displayed the lowest average fertility levels. These patterns highlight the presence of marked regional disparities in fertility across Romania (Figure no. 1).

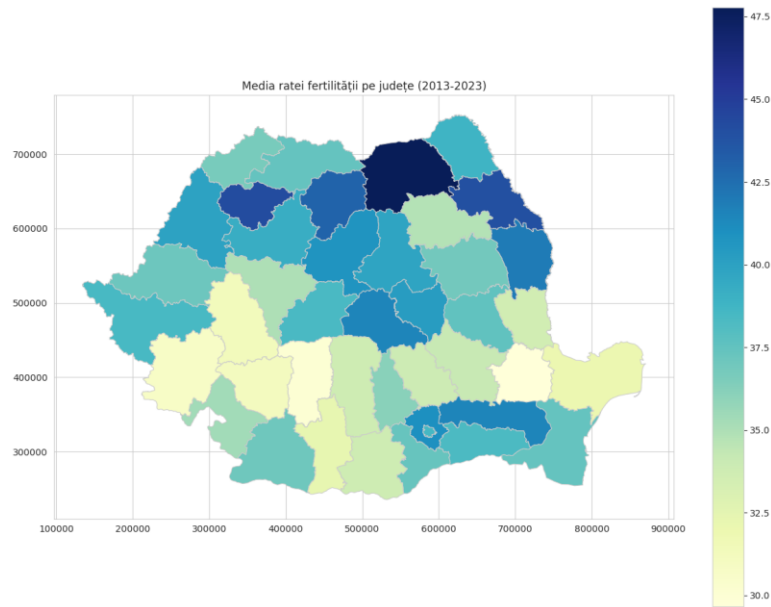


Figure no. 1: Average fertility rate by county in Romania (2013-2023)

Source: Authors' own contribution

To investigate whether fertility patterns exhibit spatial dependence, the global Moran's I test was applied annually. Moran's I measures the extent to which counties with similar fertility rates are geographically clustered (Moran, 1950; Anselin, 1995). The results confirm a statistically significant tendency for counties with similar fertility levels to cluster, with p-values consistently below 0.01. Interestingly, a slight decline in Moran's I was observed in 2020 (0.2783) and 2021 (0.2792), likely reflecting the influence of the COVID-19 pandemic on reproductive behaviour and its spatial distribution (Figure no. 2).

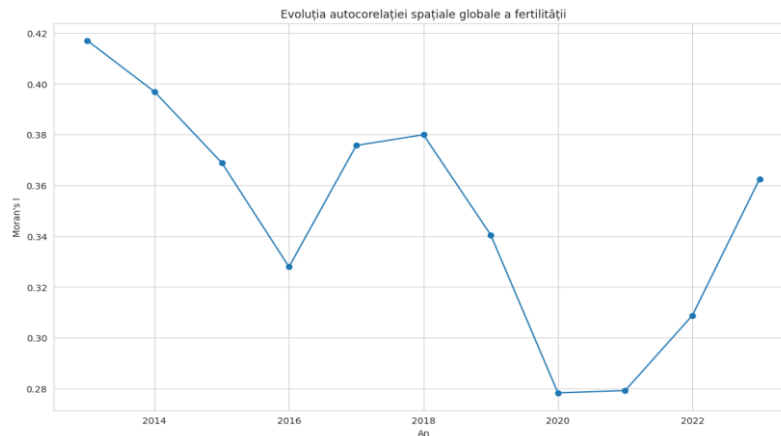


Figure no. 2: Evolution of global spatial autocorrelation of fertility in Romania (2013-2023), measured using the Moran's I

Source: Authors' own contribution

To go deeper, the LISA (Local Indicators of Spatial Association) maps (Annexes) for each year will be analysed to identify statistically significant clusters, and implicitly counties where fertility rates are similar to those of neighbours or which present isolated values. The paper kept the maps for the years 2013, 2016, 2020 and 2023 to highlight the relevant stages in the formation, expansion and reconfiguration of significant territorial clusters.

To provide a more detailed spatial perspective, Local Indicators of Spatial Association (LISA) maps were analysed for each year to identify statistically significant clusters. This analysis allows the detection of counties whose fertility rates are similar to those of neighbouring counties, as well as those that exhibit isolated values. For the purposes of this paper, maps for the years 2013, 2016, 2020, and 2023 were selected to illustrate key stages in the formation, expansion, and reconfiguration of significant territorial clusters.

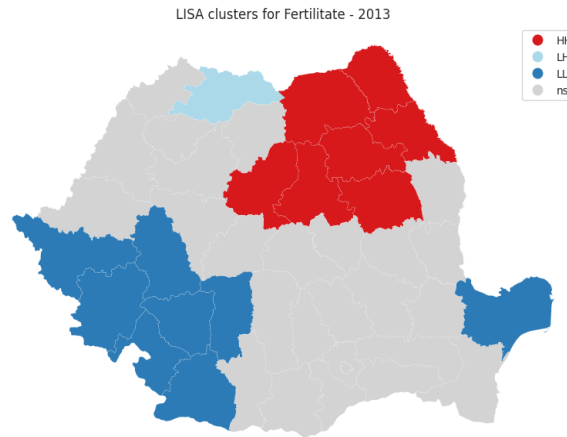


Figure no. 3: LISA map illustrating local spatial autocorrelation of fertility in 2013

Source: Authors' own contribution

The 2013 map reveals a stark spatial duality in Romania's fertility rates, characterized by two massive, cohesive blocks. A prominent High-High (HH) cluster dominates the Northeast and Central-East regions (specifically across Suceava, Botoșani, Iași, Neamț, Bacău, and Vaslui), indicating a strong contiguous zone where counties with high fertility rates are surrounded by others with similarly high rates. Conversely, the Southwest is covered by a large, solid Low-Low (LL) cluster spanning Caraș-Severin, Mehedinți, Gorj, Dolj, and Olt, representing a region of uniformly low fertility. A small, isolated Low-High (LH) outlier appears in the North, representing a "cold spot" county with low fertility surrounded by the high-fertility northern cluster. This year sets a baseline of clear regional divides with very little transitional noise.

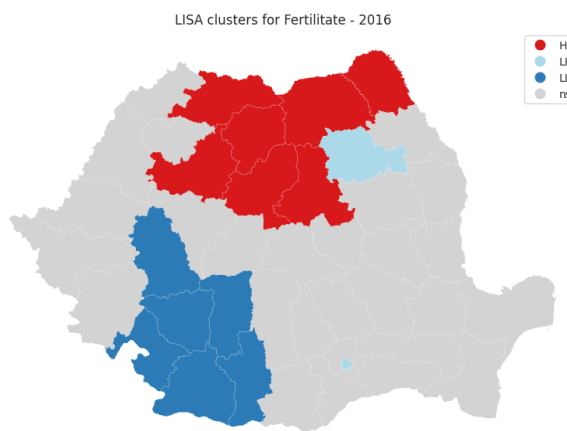


Figure no. 4: LISA map illustrating local spatial autocorrelation of fertility in 2016

Source: Authors' own contribution

By 2016, the major clusters show strong continuity but with subtle shifts in their periphery. The massive HH cluster in the Northeast remains robust, maintaining its core shape. However, the outlier dynamic shifts significantly. This indicates that while the centre of the Moldova cluster held firm, its southern periphery (near Neamț) began to experience a relative dip in fertility compared to the high rates in neighbouring Suceava and Covasna. Meanwhile, the low-fertility block in Oltenia (Gorj, Dolj, Olt) remains largely intact with the Banat region (Timiș) dropping out of the significant cluster.

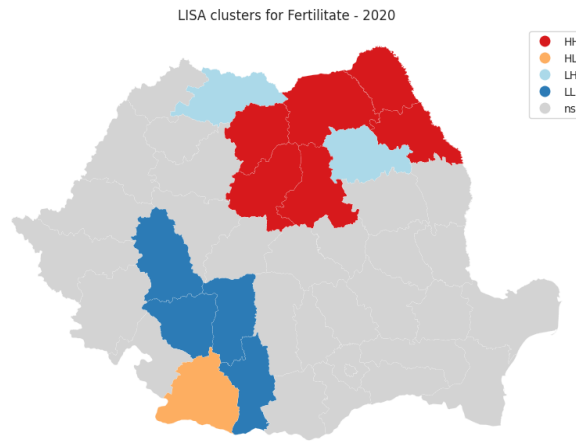


Figure no. 5: LISA map illustrating local spatial autocorrelation of fertility in 2020

Source: Authors' own contribution

The 2020 map represents the most volatile period in this timeline. The defining feature is the radical transition of Dolj county. Previously a core member of the Low-Low cluster, Dolj emerges as a High-Low (HL) outlier, a high-fertility island surrounded by low-fertility neighbours like Olt and Mehedinți. This suggests a sudden, localized surge or reporting anomaly distinct from the region. Simultaneously, the outlier landscape complicates: Maramureș reappears as a Low-High outlier in the North, and Neamț persists as one in the East. This year marks the peak of heterogeneity, where local county dynamics (Dolj, Maramureș) begin to override broader regional trends.

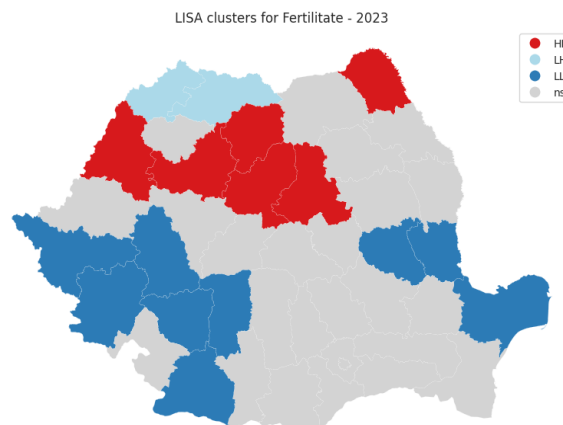


Figure no. 6: LISA map illustrating local spatial autocorrelation of fertility in 2023

Source: Authors' own contribution

In the final stage of the analysis, the 2023 map demonstrates a significant fragmentation of the previously solid spatial blocs. The high-fertility cluster migrates from Moldova toward the centre of the country. The new core is formed by Bistrița-Năsăud, Mureș, Cluj, and Harghita, suggesting that high fertility is now more associated with the central Carpathian arc than strictly with the Moldova plains. Botoșani is left behind as an isolated island. Conversely, low fertility aggressively re-conquers the West (Timiș, Arad) and engulfs the South-East (Tulcea, Brăila, Galați), creating a cluster of low fertility around the country's southern and western borders. The overall picture is one of dispersal, where the clear-cut regional divides of a decade ago have eroded into smaller, more localized pockets of fertility behaviours.

The spatial evolution of fertility in Romania between 2013 and 2023 tells a story of fundamental reconfiguration, moving from a sharp East-West polarization to a complex "center-periphery" dynamic. Initially, the country was divided by a clear demarcation line: a solid, monolithic block of high fertility in the Northeast (Moldova) contrasted with a contiguous belt of demographic decline in the Southwest (Oltenia). However, over the decade, this regional cohesion fractured. The "fertility core" effectively migrated westward, detaching from the traditional Moldova plains to re-anchor itself in the central

Carpathian arc, while leaving counties like Botoşani isolated. Simultaneously, the zones of low fertility expanded aggressively from their Oltenian stronghold to encircle the country's borders, creating a broad arc of decline that now encompasses the Western and Southeastern plains. This reorganization was accompanied by increasing fragmentation, where broad regional trends were punctured by localized anomalies suggesting that Romania's demographic map is evolving from uniform regional blocs into a patchwork of localized, disparate behaviours.

While the LISA analysis provides valuable insights into the localised spatial clustering of fertility and highlights counties that deviate from their neighbours, it remains primarily descriptive and does not quantify the underlying relationships between fertility and its socio-economic determinants.

4.2. Spatial Econometric Estimations and the Determinants of Fertility

To investigate the drivers of fertility across Romanian counties while explicitly accounting for spatial dependence, a step-by-step econometric modelling approach was implemented. As described in the methodology section, all the variables were transformed into specific rates in order to avoid distortions generated by differences in county size. Table no. 2 summarizes the estimation results for the baseline non-spatial fixed effects (FE) model, together with three spatial specifications: the Spatial Autoregressive Model (SAR), the Spatial Error Model (SEM), and the more comprehensive Spatial Autoregressive with Autoregressive Disturbances (SARAR).

Table no. 2: Results of the step-by-step econometric modelling approach

Variable	Baseline (OLS)	SAR	SEM	SARAR
GDP per capita	-0.00005***	-0.00001	-0.00004***	-0.00002
Social assistance rate	-0.515***	-0.289***	-0.302***	-0.334**
Female activity rate	0.239***	0.088**	0.202***	0.128***
Crude emigration rate	-1.874***	-1.256***	-1.565***	-1.401**
School enrolment rate	-0.108***	-0.039**	-0.050**	-0.049**
Spatial lag	-	0.574***	-	0.445***
Spatial error	-	-	0.653***	0.078
Pseudo R-square / R-square	0.833	0.900	0.8230.893	

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Source: Authors' own contribution

The choice of the SARAR model as the main specification was guided by spatial diagnostic tests. The initial non-spatial model revealed strong spatial autocorrelation. Both the LM test for spatial lag (LM-lag = 268.14, $p < 0.0001$) and the LM test for spatial error (LM-error = 285.17, $p < 0.001$) were highly significant, indicating that spatial processes were clearly present in the data. In this context, the SARAR model provides the most appropriate framework, as it simultaneously captures endogenous spatial spillovers and spatially correlated omitted variables.

The results of the SARAR estimation reveal several important patterns that were not visible in earlier analyses. Most notably, GDP per capita is not statistically significant, suggesting that higher regional income levels do not automatically translate into higher fertility once other structural factors are considered. This finding indicates that macroeconomic prosperity alone does not directly shape reproductive decisions.

In contrast, the social assistance rate has a significant effect on fertility ($\beta = -0.334$, $p < 0.05$). This result suggests that areas characterized by higher reliance on minimum income support tend to experience lower birth rates, reflecting the discouraging effect of economic insecurity on family formation.

Another key result concerns the role of women's participation in the labour market. The female activity rate has a positive and significant effect on fertility ($\beta = 0.128$, $p < 0.01$). This finding supports the idea that, in the contemporary Romania, stable dual-earner households and the additional financial security generated by female employment create more favourable conditions for having children. In this sense, the

results challenge the traditional assumption that women's employment and motherhood necessarily conflict with each other.

Migration dynamics also play a major role. The crude emigration rate shows a negative association with fertility ($\beta = -1.401$, $p < 0.05$), reflecting the demographic impact of the continuous outflow of individuals of reproductive age who relocate abroad.

Finally, the school enrolment rate is negatively associated with fertility ($\beta = -0.049$, $p < 0.05$). One possible explanation relates to the increasing burden and financial investments required for children's education. Households may choose to have fewer children but invest more resources in each child.

The spatial parameters confirm that fertility is not simply a local phenomenon. The spatial lag coefficient ($\rho = 0.445$) is positive and significant, indicating the presence of strong spillover effects. In practice, this means that fertility levels in one county tend to be influenced by those observed in neighbouring counties, likely through shared socio-cultural norms, regional labour market dynamics, and similar institutional environments.

5. Conclusions

The study examines fertility dynamics in Romania between 2013 and 2023 from a spatial, demographic, and socio-economic perspective. The results show that fertility is not randomly distributed across the country but tends to cluster geographically. Clear patterns of persistent high and low fertility regions can be observed, while several local outliers suggest that county-specific conditions also play an important role. These findings are consistent with the work of Jemna and David (2018), who argued that regional disparities and spatial heterogeneity are defining characteristics of fertility patterns in post-transitional Romania.

The empirical results obtained from the SARAR spatial panel model suggest that current policy approaches to demographic decline may need to be reconsidered. The fact that GDP per capita does not have a statistically significant effect indicates that general economic growth alone is unlikely to increase fertility rates. Instead, the results point toward the importance of financial stability at the household level. In particular, the strong positive effect of female labour force participation suggests that policies supporting work-life balance are likely to play a crucial role. These findings are in line with the theoretical framework proposed by Fent et al. (2013) and Voicu and Papuc (2023), which emphasise that enabling women to participate in the labour market while maintaining family plans is an important condition for stabilizing fertility in modern societies.

At the same time, the negative effects associated with both social assistance dependency and high educational burdens (proxied by the school enrolment rate) suggest that families face substantial economic constraints. These results mirror the classic "quantity-quality trade-off" dynamics (Jungho, 2023) and underscore the argument that severe economic precarity acts as a deterrent to family expansion (Ghețău, 2018). From a policy perspective, this implies that reducing the financial costs associated with raising and educating children may be more effective than relying primarily on passive social assistance.

Another important result concerns the strong negative impact of emigration. As highlighted in recent census-based assessments (Andrei et al., 2022), the continued loss of the active-age population fundamentally undermines reproductive potential. As a result, any attempt to address fertility decline must also be linked to broader strategies aimed at retaining young people and encouraging return migration.

Several limitations should be noted. First, the analysis relies on aggregate county-level data, which may obscure intra-county heterogeneity in fertility behaviours. Fertility behaviour can vary significantly between urban and rural areas or between different socio-economic groups, and these variations are not fully captured in the current framework. Second, while the SARAR model accounts for spatial and temporal dependence, it does not capture all potential unobserved social or cultural factors that may influence reproductive decisions, such as individual attitudes toward family size or informal childcare arrangements. Third, the study period (2013–2023) includes exceptional events, such as the COVID-19 pandemic, which may have temporarily disrupted fertility trends and may not reflect long-term structural patterns.

Future studies could extend this analysis in several ways. First, integrating micro-level data on household characteristics, education, and employment could provide a more nuanced understanding of fertility determinants. Second, exploring the impact of policy interventions, such as parental leave reforms or childcare subsidies, would help evaluate their effectiveness in different spatial contexts. Third, comparative

studies with other Central and Eastern European countries could highlight shared regional patterns and inform cross-national policy lessons. Finally, incorporating cultural and attitudinal variables could deepen insights into the complex interactions between social norms, economic conditions, and fertility behaviour.

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