Spatial Econometric Analysis of the Interrelations of Spatial and Within-Region Income Inequality The Case of Hungary

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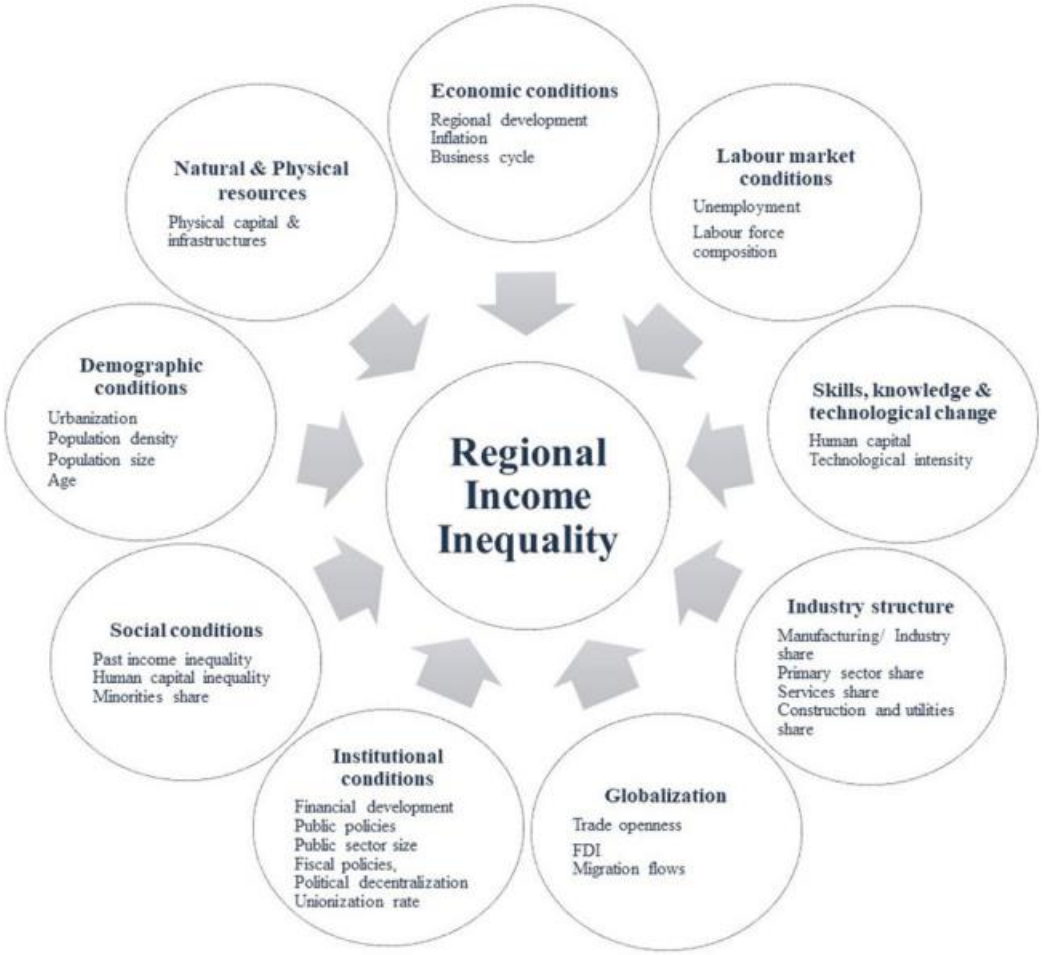
(This extended abstract represents the first draft of an early-stage, pilot research project. As such, it should be considered a preliminary contribution that lays the groundwork for a more comprehensive future study. The findings, interpretations, and methodological choices are subject to further refinement as the research progresses.)

Introduction

In the context of accelerating globalization, digitalization, and the energy transition, regional disparities and socio-economic polarization have become increasingly salient across both developed and emerging economies. These mega-trends are restructuring labor markets, reshaping local economies, and magnifying inequalities in access to resources, opportunities, and wealth. Hungary, as a post-socialist economy and EU member state, provides a compelling case for analyzing the evolution of spatial and within-region income inequalities during a decade of robust economic growth and significant policy transformation (Vida 2022, Vas et al. 2024).

This research is grounded in a multidimensional conceptual framework that captures the diverse and interrelated factors shaping within-regional income inequality (Barros-Teixeira 2021). As illustrated in Figure 1, income disparities across regions are not determined by a single variable but are the result of a complex interplay between economic, demographic, social, institutional, and environmental forces. Key influencing domains include economic development levels, labor market structure and composition, globalization (e.g., trade openness and FDI), skills and human capital, industry structure, and institutional quality. Each of these factors contributes uniquely to either amplifying or mitigating income disparities, and their effects often vary by spatial context.

Fig 1. Factors influencing within-region income inequality according to (Barros-Teixeira 2021)



Source: (Barros-Teixeira 2021)

This comprehensive framework provides the theoretical justification for the inclusion of a wide array of explanatory variables in the spatial econometric models used in this study. It also supports the methodological decision to apply Eigenvector Spatial Filtering (ESF), ensuring spatial dependencies are properly accounted for when exploring the drivers of inequality.

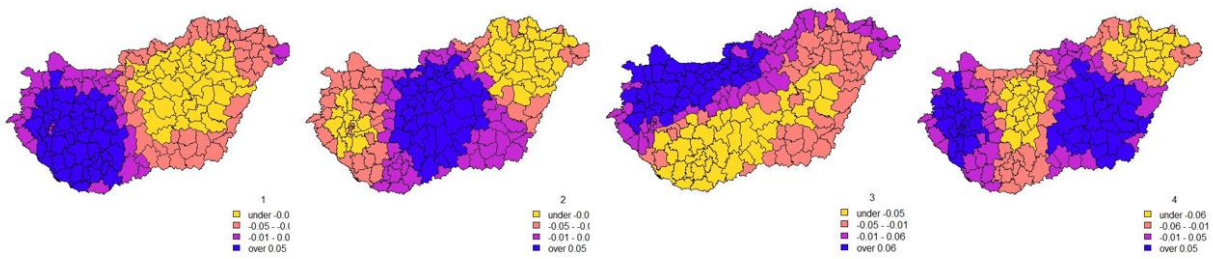
Research Framework and Methodology

The analysis builds upon the theoretical work of Barros and Teixeira (2021), who argue for a comprehensive, multivariate understanding of within-region income inequality determinants. Inspired by their meta-analytical framework, this study applies a spatial econometric methodology, particularly the Eigenvector Spatial Filtering (ESF) approach, to address spatial autocorrelation in cross-sectional regressions at the LAU1 level (175 districts). Traditional OLS models are compared with spatially adjusted models for the years 2011 and 2019 to reveal the extent to which spatial structure affects results.

The dependent variable is a weighted Gini coefficient that captures income inequality within districts. Independent variables include indicators related to globalization (export intensity, share of foreign citizens), labor market structure (employment rate in high-prestige occupations, educational dispersion, public employment participation), industrial and technological structure (FEOR-based occupation types, digital activity levels), infrastructure (road density, housing quality, internet access), and socio-demographics (aging index, population density, Roma population ratio ect.). The primary data sources for this analysis are the Hungarian Central Statistical Office (KSH) and other national statistical institutions, which provided reliable, district-level socio-economic indicators for the years under study.

The Eigenvector Spatial Filtering (ESF) method is employed in this study to address the issue of spatial autocorrelation in regression residuals, which can bias standard econometric models when analyzing geographically structured data. ESF works by constructing a set of synthetic proxy variables—eigenvectors—derived from the spatial connectivity matrix (C), which represents spatial relationships among territorial units. These eigenvectors capture latent spatial patterns that are otherwise unaccounted for in traditional models. By including the most relevant eigenvectors as control variables in the regression, the ESF approach effectively removes spatial dependence from the residuals, thereby improving model specification and inference validity. In this study, the ESF-adjusted models reveal shifts in coefficient significance compared to baseline OLS models, confirming the importance of controlling for spatial effects when investigating the determinants of regional income inequality.

Fig 2. The Eigenvector Spatial Filtering (ESF) method stages illustrated by the Hungarian LAU1 districts

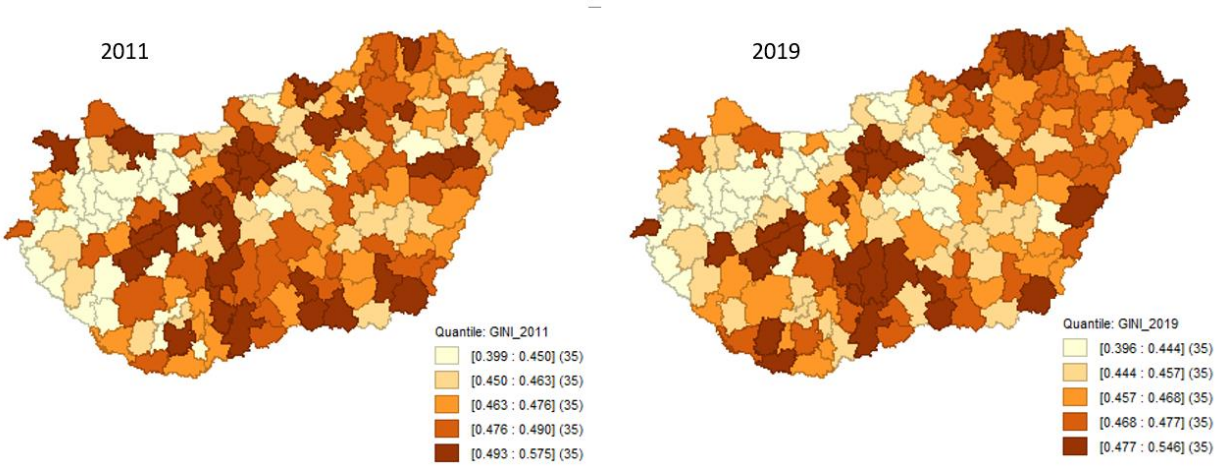


Own elaboration

Key Findings

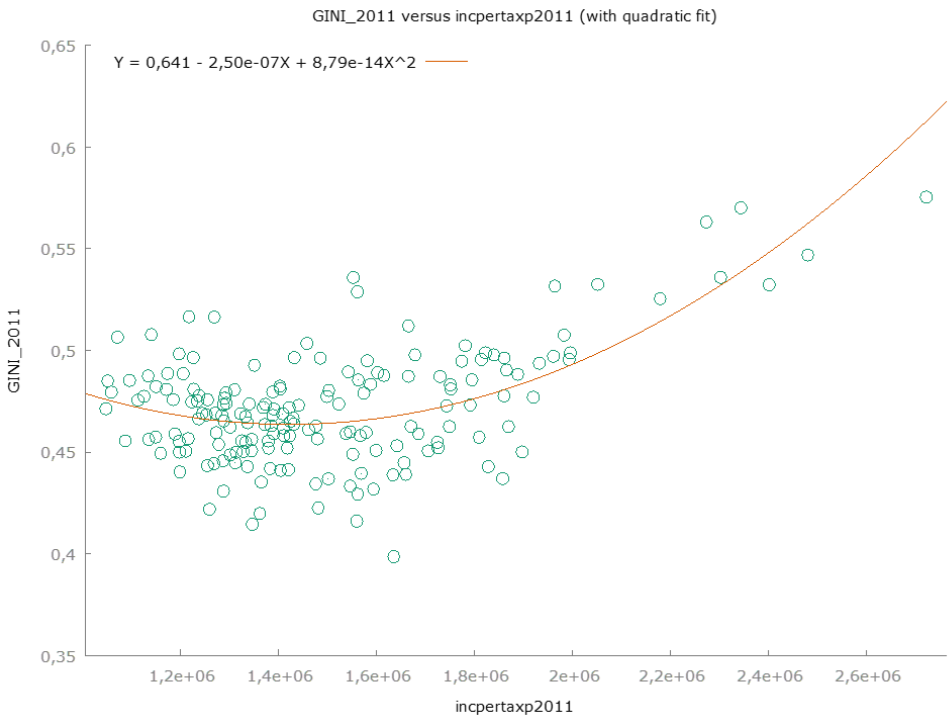
The findings present a nuanced picture of inequality dynamics in Hungary over the study period. Although regional income convergence occurred between 2011 and 2019—evident in the decreasing spatial income inequality measured by the Coefficient of Variation—within-district income disparities inside the regions remained persistent and even intensified in many areas.Temporal Trends is that, after the post-crisis rebound in 2010, territorial income inequality decreased across all spatial levels betwen 2011 and 2019. Despite this spatial convergence, Gini coefficients calculated within districts revealed increasing internal polarization, especially in high-income urban districts and peripheral rural zones (Fig 3., Fig 4.).

Fig 3. Inequality in per capita income within the Hungarian districts



Own elaboration

Fig 4. Interrelations between whitin-regional inequality patterns (GINI_2011) and average income per taxpayers data (incpertaxp2011 HUF),



Own elaboration

Determinants of Inequality:

A U-shaped relationship was observed between per capita income and income inequality: both the poorest and wealthiest districts exhibited higher inequality levels. Labor market segmentation (particularly education-based employment divergence) and low digitl activity correlated strongly with higher within-district inequality. The share of employment in public works programs in 2013 had a negative association with inequality, suggesting a short-term equalizing effect. Globalization-related indicators had a moderate but significant effect, especially export intensity in earlier years. Educational dispersion (CPE of employees) and the share of the Roma population were both statistically significant in explaining inequality patterns.

Spatial Autocorrelation and Model Improvement: The Moran's I values confirmed the presence of significant spatial autocorrelation in the residuals of baseline OLS models. After applying the ESF model, spatial effects were successfully filtered out, leading to changes in coefficient significance and model reliability. The ESF results confirmed the need for spatial correction when analyzing income disparities across interlinked territories.

Conclusion and Policy Implications

This study underscores that economic spatial convergence among regions does not automatically result in social inclusion or reduced inequality within them. The Hungarian experience during 2011–2019 demonstrates how growth and income improvements can coincide with persisting—and in some areas worsening—within-region income inequality.

By integrating spatial econometric tools with inequality metrics, this research contributes both methodologically and empirically to understanding the territorial and social dynamics of income inequality. Its findings support a more refined, spatially aware policy framework that promotes not just convergence, but cohesion and fairness. These results highlight the importance of adopting place-based development strategies in policy design. Uniform economic development policies may reduce regional disparities on average, but without targeted intra-regional interventions, social cohesion within districts may erode.

Policy recommendations include: Improving Access to Education and Digital Infrastructure: Investments in digital skills and infrastructure, especially in peripheral and disadvantaged districts, can bridge opportunity gaps. Tailored Labor Market Interventions: Supporting mobility, professional retraining, and public employment programs that target inequality hotspots. Monitoring Spatial Effects: Applying ESF or similar spatially sensitive methods in policy impact assessments to prevent misleading interpretations.

Main references

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