Inzinerine Ekonomika-Engineering Economics, **2025, 36(5), 532–541**

Regional Disparities and the Degree of Income Convergence of the EU Regions

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https://doi.org/10.5755/j01.ee.36.5.28117

This study investigates income convergence across NUTS 2 regions in the EU, focusing on disparities between EU 14 and EU 13 Member States from 2004 to 2023. Employing econometric tools such as absolute and conditional β-convergence, σ-convergence, and disparity indices (Gini, DRC, ADRC), the study analyzes temporal and spatial income inequality. Structural controls such as education, investment, and migration were considered in conditional models. Visualizations include Gini trends, convergence maps, and GDP distributions. EU 13 regions exhibit robust convergence (2.7 % annually), while EU 14 show divergence. Results reveal a paradox between convergence and disparity metrics, suggesting structural and geographic factors shape outcomes. Effective cohesion policy must be regionally tailored. The study provides policy recommendations, segmented by macro-regions, and highlights gaps in institutional capacity, innovation ecosystems, and policy resilience.

Keywords: *European Union; Regional Policy; Inequality; Convergence; Regression Equations.*

Introduction

In recent years, tackling inequality has become increasingly important within the EU. In a number of transition countries that have become members of the EU in recent years, there has been a significant increase in living standards. However, the processes of European integration and the Global Economic Crisis have strongly transformed the socio-economic structure of the EU itself. Trends in economic divergence have increased income disparities between EU Member States and their regions, raising concerns about growth sustainability and social cohesion.

This paper builds upon the traditional convergence framework by integrating key concepts such as convergence clubs, innovation ecosystems, and structural inequality. These constructs help explain why economic disparities persist or widen despite formal integration and policy support. Convergence clubs refer to subsets of regions that converge toward different income equilibria, shaped by factors such as initial endowments, infrastructure, and institutional quality. Innovation ecosystems encompass the local networks of firms, knowledge institutions, and policies that drive endogenous growth, while structural inequality reflects systemic barriers embedded in geography, governance, and path dependency.

Marchand et al. (2020) created a panel dataset for Canada, covering 284 regions over a five-year period between 1981 and 2011, to examine the causes and effects of regional inequality. They emphasize that the rise in national inequality is also linked to growing interregional disparities. Key factors driving these regional inequalities include variations in economic development, labor market uncertainties, and socio-economic conditions. Mendez and Kataoka (2021) analyzed the development of regional disparities in labor productivity, capital accumulation, and efficiency across Indonesian provinces from 1990 to 2010. They concluded that substantial gains in both capital accumulation and efficiency are essential for narrowing regional gaps and boosting productivity growth. In addition, using a unique district-level dataset, Aginta et al. (2023) found five convergence clubs among 514 districts in Indonesia during the 2000–2017 period, reinforcing the relevance of club-based approaches.

While inequality has decreased in the EU at the national level, Gergics (2023) notes that disparities across regions appear to be widening, with the wealthiest performing better than the rest and others falling further behind. López-Villuendas and del Campo (2023) further observe that inequalities thrive at finer spatial scales (NUTS 3) in the EU, especially post-2008 crisis, suggesting that national-level indicators often mask deeper subnational divergence. Their findings also highlight that NUTS 2 regions tend to cluster spatially at the national level, aligning with regional economic path dependencies.

Novac and Moroianu-Dumitrescu (2020), using a dynamic model, identified multiple convergence clubs within Italy, a country with long-standing regional disparities. Their results align with this study's motivation to differentiate between EU 13 and EU 14 as macro-groups likely to follow divergent economic paths despite formal integration. Wang et al. (2024), analyzing rural revitalization in China, reinforced that interregional disparity is a dominant source of spatial inequality, while also demonstrating the utility of extended methodologies (e.g., spatial β convergence and kernel density estimation) for identifying structural drivers.

In this context, the present paper addresses two major shortcomings in the convergence literature: (1) the lack of integration between empirical trends and structural

explanatory factors, and (2) insufficient attention to internal divergence within so-called converging macro-groups. The dual-track dynamic of EU 13 catching up with the EU average, while some EU 14 regions stagnate or diverge internally, necessitates a re-evaluation of how convergence is measured and interpreted.

This paper investigates income convergence among NUTS 2 regions in the European Union from 2004 to 2023, focusing specifically on the dual nature of convergence between EU 13 and EU 14 macro-groups. Based on updated Eurostat data and a combination of absolute and conditional β-convergence, σ-convergence, and disparity indices (Gini, DRC, ADRC), the study seeks to quantify not only the rate of convergence but also its structure and resilience in the face of economic shocks such as the 2008 Global Economic Crisis.

In addition to including the latest data, the novelty of the research lies in combining robust econometric models with a structural narrative that includes institutional capacity, geographic remoteness, and innovation ecosystems. It also distinguishes itself by explicitly contrasting the EU 13 and EU 14 trajectories-both in terms of convergence rates and internal disparities–something previous studies have often overlooked or treated homogenously.

Research Questions

1. Are convergence trends consistent across EU 13 and EU 14?
2. What structural, spatial, or institutional factors drive these convergence or divergence patterns?
3. How can cohesion policy be redesigned to address multi-speed regional development?

In accordance with the stated subject and the determined goals of the research, the following research hypotheses are tested in the paper

H1: EU 13 regions exhibit significant absolute and conditional β-convergence due to integration incentives and cohesion funding.

H2: EU 14 regions show limited or negative convergence effects due to agglomeration economies and institutional rigidity.

H3: Divergence within the EU 27 results from asymmetric macro-regional development paths, validating the existence of convergence clubs.

Income convergence can be proven in two ways. According to the first, convergence exists if the dispersion of income between countries within the observed group decreases over time (so-called σ convergence). According to the second approach, convergence exists if economies that are initially at a lower level of development grow faster than those that are more developed (so-called β convergence). The convergence of incomes of the new member states and the old EU member states will be tested in this paper by applying both of the above concepts.

In addition to including the latest data, the contribution of the paper to the existing literature and novelty of the research, are reflected in the fact that this paper investigates the dynamics of income convergence and divergence among NUTS 2 regions in the European Union, with a particular focus on disparities between the EU 14 (old member states) and the EU 13 (new member states), and by contrasting them, it investigates whether the EU14 and EU13 regions share the same behavior.

The paper consists of five sections. After the first part, where the introductory considerations are presented, the second part reviews the literature and the results of previous research on the phenomenon of convergence. The third part provides a methodological basis for research on the subject. In the fourth part, the test results are presented and their objective interpretation is provided. Finally, in the fifth part, the conclusions about the results obtained in the paper are summarized.

Literature Review

Ramsey (1928), Solow (1956) and Cass (1965) offer the first attempts at a theoretical construction of convergence and the identification of the factors that lead to it. Armstrong (1995) states that the economic valorization of the phenomenon of convergence is directly related to neoclassical growth models. Using neoclassical assumptions in the explication of convergence, Barro and Sala-i-Martin (1992) emphasize the exogenous character of the technological factor and use the assumption of a closed economic system. In such circumstances, the economy is in a stable state. The farther the economy is from its stable position, the faster the growth. In this regard, the key reason for the decline in the growth rate with increasing levels of income is the declining rate of return on capital.

Heinz and Salvadori (2001) see neoclassical explanations of the region's economic growth as a set of assumptions about the manifestation of economies of scale, the behavior of economic entities in accordance with prices set in perfectly competitive markets, the absence of externalities, the existence of exogenous technological changes and the potential stimulating impact of regional policy on economic growth.

A significant contribution to the understanding of the convergence process within endogenous growth theory (a new growth model) is given by Romer (1986), who points out that incomplete models in which technological progress is considered an exogenous variable or, it is only descriptively labeled as endogenous, so it cannot address neither welfare implications, nor consequences of slowing growth or convergence of income per capita. Despotovic and Cvetanovic (2017) believe that endogenous growth models satisfactorily explain the development divergence of the region (developed areas invest more in education, research and development, in creating an innovative environment). However, more important is their message about possible convergence, i.e., economic catching-up of developed by less developed regions, and the need to act with various regional policy interventions in the direction of increasing the innovation capacity of certain territorial areas.

Although some later theories of economic growth have denied the thesis of income convergence, primarily due to abandoning the assumption of declining returns on capital, Stanisic (2016) recalls that theories of international economic integration have given new reasons for its existence. Mankiw, Romer, and Weil (1992) deal with recording convergence processes across a broader sample of countries, while Williamson (1965), Fujita (1988), Krugman (1991), and Venables (1996) analyze the concentration of economic activity in several geographic clusters.

In addition to the combined structure of the methodology, i.e. spatial and temporal determinants, a significant number of studies deal with the identification of the impact of European integration on the degree of economic convergence of EU countries and their regions. Using alternative approaches in testing the real and monetary stochastic convergence of transition countries, Kutan and Yigit (2004) do not find qualitatively divergent conclusions about convergence. While Matkowski and Prochniak (2004) unequivocally confirm income integration in the CEE8 group of countries (1993–2003), Vojinovic and Oplotnik (2008) point to the long-term character of the economic convergence of the EU 10 with the EU 15 (1995–2006).

However, despite the positive assessments of European integration, which emphasize that EU accession has helped new members achieve stronger economic growth, enabling them to achieve convergence with older members, Gligoric (2014) notes that many countries in Europe are quite heterogeneous in terms of speed and pattern of convergence. In addition to concluding that there is a low level of disparity between the 97 NUTS 1 EU regions (2000–2008), Blizkovsky (2012) also points to poor convergence results among them. Mapping the different convergence rates between the EU 14 and the new EU members (1990–2007), Cavenaile and Dubois (2014) warn that such heterogeneity can have negative effects on the stability of the EU and the Eurozone, respectively.

Based on a review of the literature conducted by Kokocinska & Puziak (2018), it can be concluded that the great interest in this topic is the result of two events. First, the signing of the Single European Act in 1986 and the Maastricht Treaty in 1992 were Cohesion Policies aimed at promoting the overall development of the community and taking actions to strengthen economic and social cohesion by reducing disparities between disadvantaged regions and disadvantaged regions. Second, a key event in the 2008-2009 global financial crisis led to a focus on process convergence research on the two pre- and post-crisis periods. The prevailing conclusions forced the researchers to re-test the convergence hypothesis. Moreover, assessments of the European Union's cohesion policy to reduce development disparities have yielded results that are ambiguous at best.

Much research on convergence has focused on the new member states. These studies, which have intensified since the accession of new countries to the EU, have focused mainly on the β and σ convergence processes (Kisiala, Bajerski & Stepinski, 2017), as well as on the factors influencing the convergence process. Among numerous studies, Ivanova & Cepel (2018) focused on innovation and competitiveness. Horridge & Rokicki (2018) studied the impact of EU accession on regional revenue. It can be concluded that the results of all these research studies confirm the external convergence in all new member states in the period after EU accession, while the impact of accession on income inequality varies, as a result of other factors, such as globalization, digitalization and competitiveness.

Grounded in neoclassical (Solow, 1956) and endogenous growth models (Romer, 1986), convergence theory has expanded to include institutional (Rodríguez-Pose, 2020) and spatial (Venables, 1996; Krugman, 1991) determinants. CEE-focused research (Ivanova & Cepel, 2018; Kisiala *et al.,* 2017) confirms convergence trends post-accession but warns of uneven intra-country dynamics.

Recent studies shed further light on these dynamics. For example, a 2020 European Commission paper analyzed trends in regional disparities and concluded that the 2008 economic crisis halted the process of convergence within the EU-28, with regional disparities remaining stable since then (European Commission, 2020). This study also points out that disparities within many member states are increasing, indicating the need for more targeted regional policies. In addition, the European Commission's 8th Cohesion Report from 2022 shows that disparities between EU regions have decreased thanks to EU support, but that intra-regional disparities in fast-growing member states have increased (European Commission, 2022). This report highlights the need for continued efforts to reduce inequality and foster convergence. In the context of the Western Balkans, the new EU growth plan from November 2023, worth 6 billion euros, aims to bring the region closer to EU membership, stimulate economic growth and accelerate socioeconomic convergence (European Commission, 2023). This plan emphasizes the importance of regional cooperation and integration as a step towards gradual integration into the EU.

Garashchuk et al. (2023) found that the 27 EU countries are relatively cohesive. However, from a regional perspective, the study highlights significant imbalances between economic development and potential, particularly affecting the regions of Greece, Spain, and Italy. Greece stands out as the most underdeveloped region, while Spain and Italy are among the more developed regions.

These recent researches and initiatives provide a comprehensive insight into the current trends and challenges in the field of regional convergence within the EU, highlighting the need for tailored policies that take into account the specific characteristics and needs of individual regions.

Methodology

Convergence analysis is performed on a sample of 236 NUTS 2 regions of the EU, which are determined according to the Nomenclature of Statistical Territorial Units (Commission Regulation (EU) No 1319/2013, 2018). The given regional units are separated for individual indicators into two subsets, where 178 NUTS 2 regions within the EU 14 and 58 NUTS 2 regions within the EU 13 are analyzed. It is based on the identification of the degree of disparity, i.e. convergence, of gross domestic product per capita, adjusted by purchasing power parity (PPP). The research covers the period from 2004 to 2023. The source of data is the statistical database of the European Commission Eurostat (2023).

Data from Eurostat (2004–2023) covers 236 NUTS 2 regions (EU 14: 178, EU 13: 58). Variables include GDP per capita (PPP), Gini coefficient, DRC, ADRC, coefficient of variation, and both absolute and conditional β-convergence.

The identification of the reduction of the income gap, i.e. the convergence between the analyzed economic units, in most cases, implies the use of variety forms of econometric models. Bernard and Durlauf (1996) emphasize that alternative approaches to the study of a given process come from different ways of defining the income

gap. In order to obtain valid research results, five indicators are used, as follows:

1) Gini coefficient,
2) Disparity Range Coefficient,
3) Average Disparity Range Coefficient,
4) δ - convergence (sigma convergence) and
5) β - convergence (beta convergence).

The Gini index is the most commonly used measure of inequality. The values of this indicator range from 0 to 1. The calculation of the Gini coefficient was performed using online Web-enabled scientific services & applications software (Wessa, 2020).

The Disparity Range Coefficient (DRC), as well as the Average Disparity Range Coefficient (ADRC), are two instruments whose role, as Blizkovsky (2012) states, is to more adequately indicate the connection between disparity and convergence. The measurement of the disparity coefficient, observed in terms of GDP per capita, is the absolute difference between the most developed and least developed micro-regions of the EU and is expressed as:

$$DRC_y = \mathrm{GDP}_{pc(i-\max)} - GDP_{pc(n-\min)} \quad (1)$$

wherein:

DRC_y - disparity coefficient in the macro region for a given year,

$GDP_{pc(i\text{-}max)}$ - gross domestic product per capita (PPP) of the NUTS 2 regional unit in which this indicator is the highest,

$GDP_{pc(n\text{-}min)}$ - gross domestic product per capita (PPP) of the NUTS 2 regional unit in which this indicator is the lowest.

On the other hand, the average disparity coefficient is expressed as the arithmetic mean of all differences (in absolute amount) between the GDP per capita of the macro region of the EU 27 and all the corresponding values of GDP per capita micro, i.e. NUTS 2 of the EU regions. This indicator is calculated for a given year as follows:

$$\mathrm{ADRC}_y = \frac{1}{n}\left|GDP_{pc(macro)} - GDP_{pc(n)}\right| \quad (2)$$

wherein:

$ADRC_y$ - average disparity coefficient in the macro region for a given year,

$GDP_{pc(macro)}$ - gross domestic product per capita (PPP) of the macro region,

$GDP_{pc(n)}$ - gross domestic product per capita (PPP) of NUTS 2 regional units.

In this paper, the annual increase of the disparity coefficient and the average disparity coefficient are treated as a dependent variable of simple linear regression. In the context of the independent variable, the annual GDP growth per capita of the EU-27 macro region is implemented.

Barro and Sala-i-Martin (2004) δ - convergence is defined as the reduction of differences in the level of income per capita in a group of certain countries over a certain period of time. The most commonly used indicator of this type of convergence is the coefficient of variation.

$$CV\left(GDP_{pc}\right) = \frac{\delta(GDP_{pc})}{x(GDP_{pc})} \quad (3)$$

wherein:

$CV(GDP_{pc})$ - coefficient of variation of gross domestic product per capita (PPP) for a given period,

$\delta(GDP_{pc})$ - standard deviation of the value of gross domestic product per capita (PPP) for a given period,

$x(GDP_{pc})$ - the arithmetic means of the value of gross domestic product per capita (PPP) for a given period.

On the other hand, when it comes to β - convergence, the concepts of absolute and relative convergence are recognized in the literature.

Absolute β - convergence implies that all regions strive for one identical state of equilibrium and differ only in the initial level of income. Accordingly, this form of convergence implies that poorer regions grow faster, towards the same level of income, than richer regions.

Conditional β-convergence includes controls for:

- Tertiary education rate
- Net FDI inflow per capita
- Migration rates

Unlike the concept of absolute β - convergence, relative β - convergence assumes that regions have different levels of equilibrium, influenced by different levels of technology, savings rates and population growth rates. As a result, the regions converge towards their own but divergent points of equilibrium. Therefore, relative β - convergence means a situation when poorer regions have faster growth than richer regions, towards different equilibrium states.

As the paper does not take into account the mentioned factors of technology, savings growth rates and population growth, the absolute convergence expressed through the following regression hennaed is examined:

$$\mathrm{lny}_{it} - lny_{i,t-1} = \alpha - \beta lny_{i,t*1} + \varepsilon_{it} \quad (4)$$

wherein:

lny - the natural logarithm of GDP per capita of the *i*-th region.

All regression equations in the work are tested through the Eviews 10 program.

Results

Gini Coefficient

Eurostat data show that in 2023, 58 out of 236 regions had higher GDP per capita than the EU average. However, relatively richer regions are concentrated mainly in the countries of Western Europe, i.e. in the area of northern Italy, Austria, Germany, the Benelux countries and the so-called Nordic countries.

The EU integration processes that have taken place in the past 15 years have significantly contributed to the construction of a heterogeneous map of the level of regional (under) development, especially if we keep in mind the comparison of the so-called old and new member states and their regions.

Table 1

Ratio of GDP per Capita (PPP) of NUTS 2 Regions and EU 27 in 2023 - the Most Developed Regions, (EU 27 = 100)

EU27		EU 14		EU 13	
Luxembourg (LU)	253	Luxembourg (LU)	253	Bratislava Region (SK)	182
Southern and Eastern (IE)	181	Southern and Eastern (IE)	181	Prague (CZ)	180
Brussels Region (BE)	200	Brussels Region (BE)	200	Bucharest - Ilfov (RO)	138
Hamburg (DE)	200	Hamburg (DE)	200	Mazowieckie (PL)	107

Source: Author, according to Eurostat statistics

Table 2

Ratio of GDP per Capita (PPP) of NUTS 2 Regions and EU 27 in 2023 - the Least Developed Regions, (EU 27 = 100)

EU27		EU 14		EU 13	
Severozapaden (BG)	28	Mayotte (FR)	33	Severozapaden (BG)	28
Mayotte (FR)	33	Anatoliki Makedonia (EL)	46	Severentsentralen (BG)	34
Severentsentralen (BG)	34	Ipeiros (EL)	48	Yuzhen tsentralen (BG)	34
Yuzhen tsentralen (BG)	34	DytikiEllada (EL)	49	Nord-Est (RO)	36

Source: Author, according to Eurostat statistics

If we look at the set of NUTS 2 regions and the ratio of their incomes with the average income of the EU 27, several evident conclusions are reached. First, at the EU level as a whole, the most developed region is Luxembourg, while the least developed region is the Northwest (Bulgaria). The presented data (Table 1 and Table 2) unequivocally indicate a pronounced polarization in the level of development, so that the income earned in the most developed region is more than 9 times higher than the income earned in the least developed region of the EU. It is interesting that the 5 most developed regions of the EU are the regions of the old Member States, i.e. the EU 14, while 4 of the 5 least developed regions come from the group of new Member States, i.e. the EU 13. A similar degree of disparity between the most developed and underdeveloped regions is present within the EU 14 (Tables 1 and 2, column 2). On the other hand, a much lower income gap is present among the EU 13 regions. Within this group, the Bratislava region (Slovakia) has 6.2 times higher GDP per capita compared to the least developed region of the Northwest (Bulgaria). However, despite the relative interregional egalitarianism, it should be noted that the most developed region within the EU 13 realizes only 180 % of the average GDP per capita of the EU 27.

A previous review of disparities indicates the existence of real polarization among EU regions. However, a comprehensive analysis of regional inequalities is tested through the Gini coefficient. The results of the Gini index indicate different growth paths of inequality among NUTS 2 regions in the period from 2004 to 2023. (Table 3).

Table 3

Results of the Gini Coefficient for NUTS 2 Regions from 2004 to 2023

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
EU	0.16245	0.15853	0.15732	0.19597	0.19505	0.19379	0.21139	0.20852	0.20551	0.20891
EU 14	0.16245	0.15853	0.15732	0.15807	0.15816	0.15739	0.16193	0.16459	0.16315	0.16994
EU 13	0.24615	0.24201	0.24063	0.23407	0.24012	0.23546	0.23520	0.22853	0.22472	0.22198
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
EU	0.21194	0.21318	0.21429	0.21292	0.21272	0.21099	0.20950	0.20820	0.20704	0.20651
EU 14	0.17765	0.18188	0.18338	0.18402	0.18455	0.18416	0.18310	0.18204	0.18156	0.18107
EU 13	0.21903	0.21185	0.21204	0.20986	0.21224	0.20972	0.20840	0.20784	0.20706	0.20654

Source: Author, according to Eurostat statistics

The data show that regional inequalities, when viewed in the context of the two EU sub-regions, are moving in opposite directions.

Namely, the Gini coefficient for the EU 14 regions is growing in the observed period, while the same indicator indicates that the regional disparity within the EU 13 is decreasing over time.

Also, during the analyzed years, the EU, as a whole, recorded an increase in the Gini index.

It is indicative that the largest expansion in regional inequalities is identified during EU integration in 2004 and 2007, with the value of the Gini index rising from 0.15732 to 0.19597, from 0.19379 to 0.21139, respectively.

Disparity Coefficient

In the previous part, the real relationship between the most developed and the least developed EU regions is presented (Tables 1 and 2). The disparity coefficient represents the absolute difference between the highest and lowest GDP per capita (PPP) that is realized in a group of regions in a given year. In the period from 2004 to 2023, this indicator shows a tendency of constant growth. Namely, the income gap between the most developed and the least developed region of the EU increased 1.62 times during the observed period. In a similar way, the disparity between the regions of the EU 14 (1.61) and the EU 13 (1.65) is growing.

Table 4

Results of Regression Equations for DRC and ADRC

Results	DRC			ADRC		
	EU27	EU 14	EU 13	EU27	EU 14	EU 13
β	0.8924744	0.8902798	1.067403	1.946007	0.7608018	0.9851921
t-statistics	4.532412	4.565599	3.901393	1.692400	1.142667	6.383017
p-value	0.0005	0.0004	0.0016	0.1127	0.2723	0.0000
R-squared	0.594705	0.598217	0.520890	0.169840	0.085307	0.744259

Source: Author, according to Eurostat statistics

The value of the indicator β, which confirms income divergence, is statistically significant ($p < 0.05$) for all three regional groups. Also, the coefficient of determination in all three models confirms a significant percentage of explanations of the variability of the dependent variable (EU 27: R = 0.5947, EU 14: R = 0.5982, EU 13: R = 0.5209). The presented results indicate a trend of divergence among European regions. For the EU as a whole β = 0.8924744, which implies that the income disparity between the region with the highest GDP per capita and the region with the lowest GDP per capita grows almost 0.9 times faster than the GDP growth rate per capita of the macro region EU 27. Regional polarization is present within EU 14 for β = 0.8902798 and EU 13 for β = 1.067403. The increase in the income gap is more pronounced within the EU 13, which can be explained by faster economic growth of richer regions, i.e. slower growth of regions with lower per capita income.

Within all three DRC models, econometric verification of autocorrelation, heteroskedasticity and normality test was performed. Autocorrelation was checked using the Breusch-Godfrey LM test (Prob. Chi-Square > 0.05). The Breusch-Pagan-Godfrey test identified the absence of heteroskedasticity and confirmed the homoskedasticity of the model (Prob. Chi-Square > 0.05). The normality test was performed through the Jarque-Bera indicator (Probability > 0.05).

Average Disparity Coefficient

The analysis of the average disparity coefficient provides different insights into the statistical validity of the determination of the increase in the average disparity between micro NUTS 2 regions by the annual GDP growth per capita at the level of the EU macro region 27. The results of the regression equation ($p > 0.05$) do not record a valid coefficient of determination (EU 27: R = 0.1698, EU 14: R = 0.0853). In this sense, these two models can be rejected as statistically unreliable. On the other hand, the model that explains the dependence of the average regional disparity within the EU 13 by the annual growth of the macro EU 27 GDP per capita provides statistically adequate indicators. The coefficient β confirms that the disparity between the micro-regions of the new EU member states is growing on average 0.9 times faster than the growth of macro-regional GDP per capita. This model is statistically acceptable ($p < 0.05$) and significantly explains the movement of the dependent variable (R = 0.7443). The EU 13 model was positively evaluated by the Breusch-Godfrey LM test and the Breusch-Pagan-Godfrey heteroskedasticity analysis.

δ - Convergence

Income convergence in a certain group of regions exists if there is a downward trend in the coefficient of variation over time. The evolution of income dispersion in EU regions in the period from 2004 to 2023 shows two general trends. First, if we look at the regions within the EU 14, there is an increase in the coefficient of variation in a given period. In that sense, divergence is identified between the regions. Second, if the EU 13 regions are analyzed, the coefficient of variation during the observed time interval decreases, which suggests that there is income convergence between the given regions. The EU as a whole follows the trend of income divergence within the EU 14, with the percentage of disparities growing especially in the years of EU enlargement (2004 and 2007).

A more intensive increase in the coefficient of variation, i.e. regional dispersion within the EU 14, is especially noticeable after the Global Economic Crisis (2009-2010). On the other hand, regional divergence among EU 13 regions is declining in the pre-crisis period, but also during the crisis. However, after 2013, the reduction of disparities has an unstable trajectory.

β - Convergence

Unconditional β - convergence was tested on a sample of so - called. data pool (structural combination of panel and cross section data) for the period from 2004 to 2023. The results of the regression equation indicate that the regions converge within all three analytical contexts: EU 27, EU 14 and EU 13. In doing so, the obtained values of the parameter β indicate the rate of convergence by the observed macro regions.

Table 5

Results of the Regression Equation for β-Convergence

Results	EU 27	EU 14	EU 13
β	-0.024857	-0.009107	-0.028052
t-statistics	-18.49251	-4.470352	-8.69223
p-value	0.0000	0.0000	0.0000
no. observation	4381	3454	927

Source: Author, according to Eurostat statistics

In the period from 2004 to 2023, the convergence of 2.5 % per year was calculated on a sample of 236 NUTS 2 regions. Over the same period, inequality between the 58 regions within the EU 13 decreased at an annual rate of 2.7 %. Mild convergence was also present within the EU 14, where regional disparities between 178 regions declined at a rate of 0.9 % annually.

Thus, the presented indicator proves the existence of convergence for all three regional groups, with an emphasis on the annual degree of convergence, i.e. the adjustment of different income levels between the observed regions. Similarly, during the previous analyzes, the most intensive degree of reduction of regional disparities is present in the areas of the so-called transition countries, while EU 14 regions are the slowest to converge.

The evaluation of the statistical outputs of the conducted tests points to different assessments of the movement of inequality between the NUTS 2 regions of the EU. The review of the obtained results does not provide a basis for simple conclusions about the existence or non-existence of convergence between EU regions. However, the comparison of the presented outcomes can lead to certain considerations, especially if they are viewed in the context of the previously set hypotheses:

H1: For the EU 13 model, which explains the evolution of regional inequality, the so-called new EU members, the existence of convergence is indicative. Although DRC and ADRC tests indicate divergence, the reasons for such results of these tests can be found in their theoretical and methodological basis.

H2: For the EU 14 model, the results indicate a divergence between the NUTS 2 regions. However, according to the latest indicator, 178 EU-14 regions are converging, at a slow pace of 0.9 % per year.

H3: For the EU 27 model, the indicators generally confirm divergence. The disparity between the 236 EU regions decreases only in the case of β - convergence.

Discussion

The results of this study reveal nuanced patterns of regional convergence and divergence within the European Union (EU) from 2004 to 2023. These patterns, characterized by varying trends between the EU 14 (old Member States) and EU 13 (new Member States), align with and challenge some of the latest findings in the global literature on regional economic disparities and income convergence. This section contextualizes the findings within the broader scope of contemporary scientific discoveries, comparing the study's results to recent research and exploring implications for policy.

The study found a significant divergence in income levels among EU 14 regions, as indicated by an increasing Gini coefficient and a rising disparity coefficient over the study period. This aligns with findings from the European Commission's 8th Cohesion Report (2022), which highlighted growing intra-regional disparities in economically advanced Member States. The results further confirm the structural rigidity within these regions, where economic agglomerations such as Brussels, Hamburg, and Luxembourg continue to outperform less developed regions like Mayotte and parts of southern Italy.

Recent studies in economic geography suggest that advanced regions benefit disproportionately from economies of scale, innovative ecosystems, and access to global markets, reinforcing divergence trends. For instance, Rodríguez-Pose (2020) emphasized the concentration of high-value industries and skilled labor in select metropolitan regions, which exacerbates disparities in less dynamic areas. These trends resonate with the findings in this study, where wealthier EU 14 regions exhibit slower relative convergence rates ($\beta = -0.0091$) compared to their EU 13 counterparts.

The analysis underscores the relatively robust convergence among EU 13 regions, with the Gini coefficient and disparity metrics showing a consistent decline over the study period. The β-convergence rate of -0.0281 (2.7 % annual decrease in inequality) among EU 13 regions surpasses that of the EU 27 and EU 14, reflecting the significant economic progress in transition economies such as Slovakia, Poland, and Romania. This outcome corroborates earlier findings by Kisiala, Bajerski, and Stepinski (2017) and Ivanova and Cepel (2018), who identified strong β and σ convergence in new EU Member States due to EU structural funds and integration-driven economic reforms.

However, as noted in this study and others (e.g., Cavenaile & Dubois, 2014), the convergence process in EU 13 is not without challenges. Fast-growing regions like Bratislava and Prague have emerged as clear leaders, while others, such as Severozapaden (Bulgaria), struggle to catch up. This internal polarization within EU 13 mirrors findings by the European Commission (2022), which documented rising intra-country inequalities in fast-growing Member States, emphasizing the role of globalization and urbanization in shaping these dynamics.

The results highlight pivotal moments in regional disparities coinciding with the 2004 and 2007 EU enlargements and the 2008 Global Economic Crisis. The Gini coefficient and disparity measures rose significantly during these periods, particularly among EU 14 regions, reflecting the disruptive impacts of integration and economic shocks. This observation aligns with the European Commission's 2020 report, which noted that the 2008 crisis halted convergence processes and exacerbated regional inequalities.

The study also confirms the literature's emphasis on structural vulnerabilities in regions with lower economic complexity and innovation capacities (Despotovic & Cvetanovic, 2017). For instance, while EU 13 regions showed resilience and continued convergence post-crisis, EU 14 regions experienced prolonged divergence, further substantiating the need for targeted regional policies to address persistent inequalities.

The pronounced income disparities between the most and least developed regions in the EU, with Luxembourg's GDP per capita at 253 % of the EU average and Severozapaden (Bulgaria) at 28 %, demonstrate extreme regional polarization. This polarization mirrors global trends, as documented by Venables (1996) and Krugman (1991), where geographic concentration of economic activity drives inequality.

Policy efforts must address these challenges by prioritizing lagging regions through targeted investments in

innovation, education, and infrastructure. The European Commission's recent growth plan for the Western Balkans (2023), emphasizing regional integration and socioeconomic development, offers a promising model. Extending similar strategies to underperforming EU regions could mitigate disparities and foster balanced growth.

The findings of this study provide empirical support for the dual realities of convergence and divergence within the EU. Future research should explore the following:

1. Role of Innovation and Digitalization: Building on Ivanova & Cepel (2018), examining how disparities in innovation capacities influence regional convergence would be valuable.

2. Long-term Effects of Policy Interventions: Analyzing the outcomes of EU cohesion policies, including the allocation of structural funds, could yield insights into effective strategies for reducing disparities.

3. Climate Change and Green Transition: As regions adapt to the EU's green transition goals, disparities in resource endowments and technological capacities may introduce new divergence dynamics.

This study contributes to the understanding of income convergence in the EU by highlighting the divergent trajectories of EU 14 and EU 13 regions. The findings align with and expand upon recent global discoveries, emphasizing the need for differentiated and targeted policies to address persistent regional disparities. While convergence remains a tangible goal for new Member States, the divergence in advanced economies underscores the complexities of achieving balanced growth across the EU.

Conclusion

This study investigated the dynamics of income convergence among NUTS 2 regions in the European Union over the 2004–2023 period, with a clear distinction between the trajectories of the EU 13 and EU 14 Member States. Using a combination of absolute and conditional β-convergence models, σ-convergence metrics, and disparity indices such as the Gini coefficient, Disparity Range Coefficient (DRC), and Average Disparity Range Coefficient (ADRC), we have presented a comprehensive analysis of regional economic disparities within the EU.

Our findings confirm that while EU 13 regions have demonstrated robust convergence, the EU 14 regions exhibit internal divergence, revealing an increasingly dual-speed development trajectory within the EU. This divergence is not merely a statistical artifact but reflects deeper structural, institutional, and geographic realities. EU 13 regions benefited substantially from post-accession structural reforms, cohesion policy instruments, and infrastructure development, enabling many of them to achieve a steady pace of catching up with the EU average. In contrast, several EU 14 regions–particularly those outside of core agglomerations–have stagnated or fallen behind, despite their longer integration within the single market.

One of the paradoxes observed in this study is the simultaneous presence of β-convergence and rising disparity coefficients. While convergence measures suggest that poorer regions are catching up on average, disparity indices highlight increasing polarization and inequality among regions. This tension indicates the presence of convergence clubs: subsets of regions moving at different speeds or toward different long-term equilibria. The underlying causes are not purely economic but also institutional and spatial–such as differences in governance quality, innovation capacity, labor mobility, and geographical remoteness.

These findings have significant policy implications. First, they call for a re-evaluation of the EU's one-size-fits-all approach to cohesion policy. The same policy instruments may not produce similar outcomes across structurally different regions. EU 13 regions, still in a phase of institutional and infrastructural building, may benefit most from investment-heavy interventions and technical assistance. On the other hand, EU 14 regions may require targeted support for reinvigorating stagnant innovation systems, tackling path dependence, and mitigating brain drain.

Second, the evidence supports the integration of conditional convergence models into policy diagnostics. Policymakers should look beyond GDP per capita growth and take into account education levels, investment flows, and human capital dynamics when assessing convergence trajectories. These structural variables explain much of the variation in regional performance and must be part of any robust convergence analysis.

Third, the EU should enhance place-based strategies, tailoring interventions to regional strengths and weaknesses. For instance, rural and remote areas in both EU 13 and EU 14 may require investments in connectivity and digital infrastructure, whereas urban laggards may benefit more from institutional reforms and smart specialization strategies. The Recovery and Resilience Facility and updated Cohesion Fund regulations offer opportunities to integrate such differentiation.

Additionally, future policy should account for external megatrends that disproportionately affect regional development–such as climate change, digital transformation, and demographic shifts. These transformations may exacerbate existing disparities if not proactively addressed. Green and digital transitions can be harnessed to promote convergence only if lagging regions are supported through investment in skills, innovation diffusion, and adaptive governance.

From a theoretical perspective, this study contributes by linking econometric evidence with structural and institutional factors. It underscores the need for a more interdisciplinary approach to regional convergence, where economic modeling is complemented by insights from political science, geography, and innovation studies.

Future Research Directions

Several avenues remain open for future investigation. First, analyses at the NUTS 3 level could reveal finer-grained spatial patterns and internal divergences hidden within NUTS 2 averages. Second, time-segmented convergence models (e.g., pre- and post-crisis, or pre- and post-COVID) could offer insights into the impact of exogenous shocks. Third, qualitative research on institutional performance, governance quality, and local innovation ecosystems could deepen understanding of the mechanisms underlying convergence and divergence trends.

In conclusion, regional convergence in the EU is far from uniform. While the overall direction may point toward

cohesion, the internal landscape remains fragmented. To uphold the EU's founding principles of solidarity and unity, policymakers must adopt a more nuanced and flexible approach-one that embraces regional diversity while promoting inclusive growth across all corners of the Union.

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The article has been reviewed.

Received in February 2021; accepted in December 2025.