

REGIONAL DISPARITIES IN ROMANIA’S RESEARCH AND INNOVATION CAPACITY: A MAZZIOTTA - PARETO INDEX APPROACH

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Abstract

This study examines regional disparities in Romania’s research and innovation capacity by assessing three complementary dimensions: research and development resources, higher-education-related human capital, and research, development and innovation infrastructure. Composite indices were constructed for Romania’s eight NUTS 2 development regions using the non-compensatory Mazziotta – Pareto method and official secondary data provided by the Romanian National Institute of Statistics and the Ministry of Education and Research.

The results reveal a pronounced concentration of RDI-related resources, human capital and institutional infrastructure in Bucharest-Ilfov, which ranks first across all three dimensions. The West Region also records above-average scores, while the South-East, South-Muntenia and South-West Oltenia regions consistently occupy the lower positions. Their low scores across all three indices indicate cumulative and mutually reinforcing weaknesses in R&D resources, human capital and research infrastructure, rather than isolated deficits in a single dimension. The North-West Region displays a notable mismatch between its comparatively strong human capital base and its weaker R&D resource position.

The findings highlight the persistence of substantial territorial disparities in Romania’s RDI capacity, which generally correlate with regional economic inequalities, and support the need for differentiated regional policies.

Keywords: regional disparities; research and development; human capital; RDI infrastructure; Mazziotta–Pareto Index; Romania

Clasificare JEL: C43, J24, R11, R58

1. Introduction and literature review

In Central and Eastern European countries, economic growth has been marked by stronger territorial imbalances than in most other parts of the European Union. The gains from post-socialist transformation have been unevenly distributed across both social groups and regions [52].

In order to reduce regional disparities, Romania established eight development regions (Fig. 1) under Law No. 151/1998, later reaffirmed by Law No. 315/2004. However, these regions are not administrative-territorial units and do not possess legal personality. Consequently, the administrative-territorial units defined by Law No. 2 of 16 February 1968 – namely the county, town, and commune – remain in force. According to the most recent official publications of the National Institute of Statistics, Romania comprises 41 counties plus the municipality of Bucharest (which holds both municipality and county competences), 319 towns, of which 103 are municipalities, and 2,862 communes [33]. Development regions represent territorial frameworks encompassing groups of counties, corresponding to the European Union’s NUTS 2 classification level, and each is served by a Regional Development Agency (RDA).

A 2025 European Commission study on national policies and cohesion indicates that, although Romania has substantially converged towards the EU average in terms of GDP per capita, intra-regional and inter-regional disparities have continued to widen. Among the NUTS 2 development regions, only the capital region, Bucharest–Ilfov, is considered developed. With the

exception of the West and Centre regions, all other development regions were included among the 47 European regions classified as “lagging behind”[22,23]. At the same time, persistent urban-rural disparities reveal an uneven model of development, confirmed by socio-economic indicators that point to a lasting contrast between “two Romanias”: one urban, dynamic and connected to the EU, the other rural, poor and isolated, marked by population loss and unemployment [49].

Romania’s territorial disparities have deep historical, cultural and economic roots [53]. Industrialization after World War II encouraged long-term rural-to-urban migration, but after 1990 the transition to a market economy and employment restructuring generated rising poverty and, in some cases, reverse migration from urban to rural areas. The decline of many small and medium-sized towns produced negative social effects, pushing some jobless people into the informal economy or back to villages, where subsistence agriculture became a survival strategy [10,18].

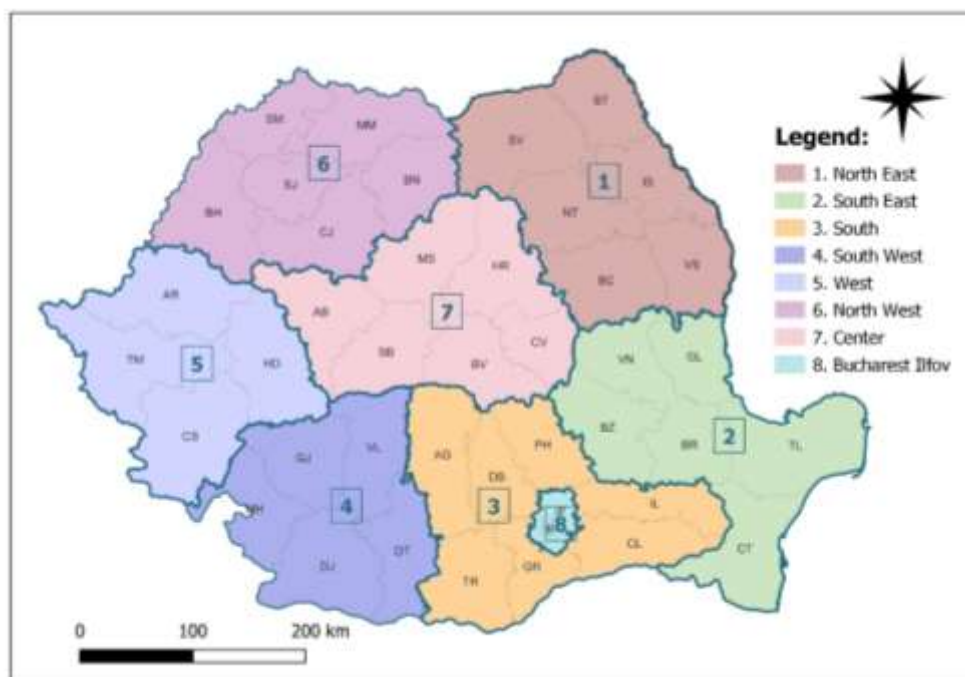


Fig. 1 Development regions in Romania

The regional disparities were visible at the time when the Development Regions were established. The 2005 National Human Development Report identified clear differences between regions in terms of economic performance, human development, unemployment, productivity, education, life expectancy, urbanisation and local development capacity. The most advantaged areas were the Centre, West and Bucharest regions, which had stronger urban systems, more dynamic economies, diversified production structures, lower unemployment and greater capacity to generate their own resources. By contrast, the South, South-West and especially the North-East displayed weaker development conditions, including higher or unstable unemployment, low productivity, weaker human development indicators, lower educational attainment and, in some cases, declining life expectancy [20].

Although the communist government had aimed to balance development levels and living standards across the country, the early post-communist period already revealed clear polarisation between more developed and less developed counties. However, despite the importance of the regional dimension for the success of Romania’s transition, it received limited policy attention for several years. Only in 1995, during the preparation of Romania’s EU accession strategy, were regional and local development issues officially recognised as essential for connecting

decentralisation and local autonomy with European integration, cross-border cooperation and spatial development [16].

The main factors involved in generating and maintaining regional disparities were considered by Lefter and Constantin [37] to be: (1) post-socialist industrial restructuring, which affected all regions with similar intensity until 2000, but after that point Bucharest-Ilfov began to recover and create jobs, while most other regions continued to lose employment, thereby increasing regional polarisation; (2) unequal investment capacity; (3) the concentration of foreign direct investment in more developed regions; and (4) the limited territorial impact of EU pre-accession funds in reducing regional disparities.

Structural changes in the employed population after 1990, resulting from the economic reforms adopted in Romania, led to changes in the economic profiles of the regions. Pintilescu's 2011 analysis of the period 1990–2008 highlighted that the North-East, South-West and, to some extent, South regions were predominantly agricultural. By contrast, in the Bucharest region, 71.6% of the employed population worked in social and trade services, while the West and Centre regions were predominantly industrial. The regions relying more heavily on agriculture were also those with the lowest levels of economic development, being characterised by the lowest values of GDP, total income and total expenditure [48]. Andronic [3] reached a comparable conclusion showing that economic growth had a significant geographical pattern, the underdeveloped areas being concentrated in the North-East, along the border with Moldova, and in the South, along the Danube. These patterns of underdevelopment were closely associated with high unemployment, the predominance of rural activities, and limited capacity to attract foreign direct investment. Differentiated trajectories were also identified by Boldea et al.: South-West Oltenia, a lagging region affected by agricultural dependence, declining mining and manufacturing, low productivity, outdated infrastructure, pollution, unemployment, poverty and out-migration, the North-East and South-East regions characterised by industrial traditionalism and limited innovation capacity, but, by contrast, Bucharest-Ilfov, South-Muntenia and the West presented a more stable development, benefiting from foreign investment, better infrastructure, proximity to markets, administrative advantages and stronger urban growth poles [11].

In the paper entitled "Identifying Regional Economic Disparities and Convergence in Romania", Antonescu [4] shows that after the creation of Romania's Development Regions, regional economic trajectories became increasingly differentiated. More competitive and attractive regions, especially Bucharest-Ilfov and the West, pulled ahead, while poorer regions lagged behind [26,51,54]. Therefore, despite a general trend of national convergence toward the EU average, Romania's internal territorial cohesion weakened due to the growing concentration of economic performance in a limited number of dynamic regions [4]. The inverse relationship between growth and performance on the one hand and regional disparities on the other had been previously highlighted by Petrakos, too [47]. The faster the pace of growth, the more likely it is that regional disparities will diminish [47]. And as in a vicious circle, foreign investments, considered an engine of development, were directed in the first post-communist decades towards more developed regions and avoided less developed areas [36]. The link between Foreign Direct Investment (FDI) and disparities between regions was also analysed by Nistor [45], and the research conclusions highlighted the fact that FDI deepens inequalities between underdeveloped regions and the Bucharest - Ilfov region. Another possible cause that led to the deepening of inequalities between regions was considered to be the fact that structural and cohesion funds had a low absorption rate (approximately 21%) and only developed regions, which already had a high degree of expertise in accessing such funds, were able to benefit from their use [57]. Regional disparities in Romania have also been examined through analyses of economic and social variables in numerous other studies [5,6,8,9,12,13,17,19,27,28,34,40,41,42,46,50].

Ianoș et al. [30] argue that many counties that experienced extensive industrialisation during the communist period became underdeveloped after the transition to a market economy, due to the

collapse of industrial activity. Their economic recovery has been slow because of poor accessibility, monocentric development, strong centre – periphery contrasts, a high share of rural population and the loss of human capital through international migration.

Other factors influencing the asymmetric development of regions are considered to be the cultural factors, represented by norms, values and institutions [46], but also the dynamics of the consulting firms sector, which are mainly concentrated in the more developed regions (Bucharest-Ilfov, West, Center and North-West) [15].

Hapenciuc and Neamtu underscore the fact that there is a correlation between the growth of gross domestic product per capita and the level of education of the population in the respective region. The authors demonstrated that as economic development increases, the share of the population with a low level of education decreases. In regions where there is a high share of the population with a low level of education, the GDP per capita is low [29]. In 2025, Zaharia stressed that educational performance in Romania, measured through baccalaureate participation and completion, has improved in some respects but remains strongly marked by regional and county-level disparities [56]. Incaltarau [32] also highlighted that migration has contributed to widening regional disparities in Romania, rather than supporting regional convergence. Although migration can have a positive effect on overall growth, its benefits are spatially uneven: richer and more attractive regions gain more, while poorer source regions tend to lose population and human capital.

Babucea [2] analysed regional disparities through the lens of regional agricultural performance, highlighting the need for regionally adapted agricultural policies. The disparities between the efficiency of agricultural farms and the need to implement regional development schemes were also highlighted by Chivu et al. [14].

Particular attention was paid to understanding the relationship between SME activity and regional disparities, with Nica et al. [44] pointing out that disparities deepened after Romania's accession to the EU. Antonia and Tigau [7] suggested that the lack of start-up capital in new firm formation in Romania substantially limits the contribution on economic growth.

A mapping of poverty and social exclusion for the period 2015 - 2024 was carried out by Iftimoaei et al. [31]. Their study reflects a significant reduction in the poverty rate that Romania recorded between 2015 - 2024, but still highlights the persistence of regional disparities, with the North-East, South-East and South-West regions being the most affected. It is mentioned that the West and North-West regions have made notable progress in reducing poverty, approaching the average values in Central Europe.

A study conducted in 2025 by Tudose et al. reconfirms that Romania's regional development follows a polarized “two-speed” model, with București-Ilfov approaching Western levels of competitiveness while the other seven regions remain trapped in a low-competitiveness cluster due to structural weaknesses in basic education, infrastructure and institutional capacity; reducing this gap requires differentiated policies, prioritizing absorptive capacity and connectivity in lagging regions and quality-of-life improvements in București-Ilfov [55].

As presented in this section, in post-communist history, many factors that generated disparities between regions have been analysed, but the influence of the Research - Development - Innovation (RDI) sector has been less highlighted. We therefore propose in the following to carry out an analysis of regional disparities through the lens of the RDI field.

2. Methodology

Although the relationship between education and regional disparities in Romania has previously been addressed, the contribution of research and innovation to the persistence of regional disparities has received limited attention. To analyse regional disparities associated with research, development and innovation capacity, we constructed composite indices comprising variables grouped into three dimensions (Table 1): Research and Development Resources (RDR Index), Human Capital (HC Index), and Research, Development and Innovation Infrastructure (RDII

Index). The selection of these variables and dimensions draws on approaches used in the literature on regional innovation systems [1,35] and in European comparative frameworks [25,43], in which regional innovation performance is assessed through standardised and aggregated indicators.

To aggregate the composite indices, we used the Mazziotta–Pareto method [38,39], a non-compensatory approach to constructing composite indices. Unlike the simple arithmetic mean, this method introduces a penalty for territorial units that display imbalanced values across indicators. Furthermore, unlike methods such as Principal Component Analysis (PCA), which prioritise variance maximisation but may reduce interpretability and be less suitable for smaller datasets, the Mazziotta–Pareto Index (MPI) provides a more transparent and policy-relevant measure of multidimensional disparities. The choice of this method is justified by the multidimensional nature of regional RDI capacity: research and development resources, human capital, and research infrastructure are not perfectly substitutable. Therefore, strong performance in one dimension should not fully compensate for deficiencies in other dimensions.

The stages involved in constructing the composite index, as outlined by Mazziotta and Pareto [38], are briefly presented below:

1. Definition of the phenomenon to be measured.
2. Selection of a set of indicators (referred to as variables in our study).
3. Normalisation of the individual indicators. This stage aims to make the variables comparable. Normalisation is required before any data aggregation because indicators often have different units of measurement. Therefore, the indicators must be converted to a common standard by transforming them into pure, dimensionless values.
4. Aggregation of the standardised indicators. This stage involves combining all components to construct one or more composite indices. Various aggregation methods are available, the most widely used being additive methods, which range from summing the rankings of the units for each indicator to aggregating weighted transformations of the original indicators. Multivariate techniques, such as Principal Component Analysis, are also frequently used [21,38].

The data used to calculate the indices in our study were obtained from the database of the Romanian National Institute of Statistics and from the website of the Ministry of Education and Research. The analysis is based on 11 variables reflecting research and development resources, human capital, and research, development, and innovation infrastructure across each NUTS 2 development region.

Unlike questionnaire-based methods, the present analysis relies on secondary data provided by official institutions. However, complete consecutive data series at the regional or county level were not available for all variables throughout the entire period analysed, from 1990 to 2024.

Accordingly, the Research and Development Resources Index (RDR) was calculated for the period 2004 – 2024, as data on the number of researchers were available only from 2004 onwards. The Human Capital Composite Index (HC) was calculated for the period 2011 – 2024. However, data for the variable “doctoral students per 100,000 inhabitants” were available only from 2014 onwards and were incorporated into the index according to their availability.

Regarding the Research, Development and Innovation Infrastructure Index (RDII), although data on the number of universities in each region were available in the database of the Romanian National Institute of Statistics for the entire 1992–2024 period, the legal and institutional framework governing innovation and technology transfer centres was established only in 2002 – 2003. Furthermore, the ERRIS platform (Engage in the Romanian Research Infrastructure System) was launched in 2015. Consequently, published data on the number of innovation and technology transfer centres were identified only from 2015 onwards, while data on the number of research institutes were available only for 2008 and 2024. Therefore, the RDII composite index was calculated only for the year 2024.

Table 1. Indices and variables at the regional level

Index	Variables
R&D Resources (RDR)	R&D expenditure per capita
	R&D expenditure as a percentage of regional GDP
	Researchers per 10,000 employed persons
	R&D personnel per 10,000 employed persons
Human Capital (HC)	Population with higher education, % of the population aged 30-34
	Students per 1,000 inhabitants
	Higher education graduates per 1,000 inhabitants
	Doctoral students per 100,000 inhabitants
RDI Infrastructure (RDII)	Universities per 100,000 inhabitants
	Innovation and technology transfer centres per 100,000 inhabitants
	Research institutes per 100,000 inhabitants

In the first stage, the variables were linearly ordered to make them comparable. The variables were then normalised using standardisation, expressed by the following formula:

$$z = \frac{x - \bar{x}}{\sigma}, \text{where:} \quad (1)$$

z – the standardised value;

x – the observed value of the variable;

$\bar{x}$ – the arithmetic mean of the corresponding distribution;

σ – the standard deviation of the corresponding distribution.

The distributions of individual variables, measured in different units, can be compared through transformations based on standard deviations, while the values obtained using equation (1) are centered around 0, and may take negative values therefore the equation which we will proceed with is (3), so that all standardised indicators are expressed on a common scale with a mean of $M = 100$ and a standard deviation of $S = 10$. The resulting values generally fall within the range of 70 – 130. The resulting model provides a set of standardised values and facilitates the identification of variables that are above the mean, namely those with values greater than 100, as well as those below the mean, with values lower than 100.

The next stage involved constructing the Mazziotta–Pareto Index (MPI), a composite index designed to assess multidimensional phenomena. This index is particularly relevant to socio-economic research because it enables comparisons among regions or countries over time using a classification methodology that is both complex and nuanced. The MPI standardises variables through a modified z-score transformation and incorporates a penalty function intended to limit compensation among different indicators. This methodology allows multiple variables to be aggregated into a single index while preserving sensitivity to extreme values. At this stage, the penalty coefficient is introduced and defined as a function of the coefficient of variation of the indicators relative to the mean value of the territorial units analysed. A greater deviation of the selected characteristic from the mean indicates a lower degree of internal balance and, consequently, a larger contribution to the penalty applied to the index [35].

The procedure for constructing the Mazziotta – Pareto Index was applied separately to each composite dimension.

For each composite index and year t , $X = [x_{ij}(t)]$ denotes an $n \times m$ data matrix, where:

$n = 8$ rows correspond to the Romanian development regions and

m columns correspond to the variables included in the dimension under consideration.

In this notation, $i = 1, \dots, 8$ identifies the development regions, $j = 1, \dots, m$ identifies the variables, and t denotes the year of observation.

The number of regions is constant, whereas m may differ across the composite dimensions according to the number of variables included in each dimension.

$$M_{x_j}(t) = \frac{\sum_{i=1}^n x_{ij}(t)}{n}; \quad S_{x_j}(t) = \sqrt{\frac{\sum_{i=1}^n (x_{ij}(t) - M_{x_j}(t))^2}{n}}, \quad (2)$$

where: $M_{x_j}(t)$ and $S_{x_j}(t)$ denote, respectively, the arithmetic mean and the population standard deviation of variable j , calculated across the eight development regions in year t . The next step involved determining the standardised matrix $Z = [z_{ij}(t)]$ which can be expressed as follows:

$$z_{ij}(t) = 100 + \left(\frac{x_{ij}(t) - M_{x_j}(t)}{S_{x_j}(t)} \right) 10 \quad (3)$$

Standardisation was performed separately for each indicator and year across the eight development regions. Therefore, each regional value was assessed relative to the mean and standard deviation of the corresponding indicator in the same year.

All variables included in the three composite indices were treated as stimulants, meaning that higher values represent more favourable outcomes. Consequently, the positive form of the standardisation formula was applied. This transformation places all variables on a common scale with a mean of 100 and a standard deviation of 10.

The aggregation of the individual indicators within each composite dimension was carried out in the final stage. For each development region, the coefficient of variation of the standardised variables was used as a penalty factor for imbalance among the variables.

$$cv_i(t) = \frac{S_{z_i}(t)}{M_{z_i}(t)} \quad (4)$$

where:

$$M_{z_i}(t) = \frac{\sum_{j=1}^m z_{ij}(t)}{m}; \quad S_{z_i}(t) = \sqrt{\frac{\sum_{j=1}^m (z_{ij}(t) - M_{z_i}(t))^2}{m}} \quad (5)$$

$M_{z_i}(t)$ represents the arithmetic mean of the standardised variables included in the composite index under consideration for development region i in year t , while $S_{z_i}(t)$ represents their population standard deviation.

While $M_{x_j}(t)$ and $S_{x_j}(t)$ are calculated across regions for each individual variable, $M_{z_i}(t)$ and $S_{z_i}(t)$ are calculated across the standardised variables within each region.

$$I_{MPI,i}(t) = M_{z_i}(t)[1 - cv_i^2(t)] = M_{z_i}(t) - S_{z_i}(t) \cdot cv_i(t) = M_{z_i}(t) - \frac{S_{z_i}^2(t)}{M_{z_i}(t)} \quad (6)$$

The penalty component reduces the composite index value when the standardised variables for a region are highly unbalanced. Consequently, two regions with similar mean values may obtain different MPI scores if one of them exhibits greater variability among its component variables.

The procedure was applied independently to each composite index. Consequently, separate MPI values were obtained for the Research and Development Resources Index (MPI-RDR), the

Human Capital Index (MPI-HC), and the Research, Development and Innovation Infrastructure Index (MPI-RDII). Accordingly, $I_{MPI,i}(t)$ denotes the MPI value obtained for development region i , in year t , for the composite index under consideration.

Annual MPI values were averaged over the study period to obtain a representative value for each region and composite index. These mean values were then used to establish separate final regional rankings for the RDR, HC, and RDII indices. Higher average MPI values correspond to higher ranking positions.

3. Results and findings

Figures 2-4 provide a graphical representation of the composite indices calculated for Romania's eight development regions in terms of Research and Development Resources (RDR Index), Human Capital (HC Index), and Research, Development and Innovation Infrastructure (RDII Index).

For the RDR Index, the highest value, 124.721, was recorded in the Bucharest – Ilfov Region, whereas the lowest value, 93.122, was calculated for the South-East Region. Regarding the Human Capital Index, the highest value, 124.165, was recorded in the Bucharest – Ilfov Region, while the lowest value, 90.672 was obtained for the South-Muntenia Region. The analysis of research infrastructure indicates that the highest index value was likewise recorded in the Bucharest–Ilfov Region, at 125.001, whereas the lowest value, 91.023, was associated with the South-Muntenia Region.

The results show that the Bucharest – Ilfov Region clearly outperforms the other regions in terms of the resources allocated to research and innovation, as well as its available human capital and research and innovation infrastructure.

The three cartographic representations also indicate that the regions located in the southern part of the country (South-East, South-Muntenia, and South-West Oltenia) recorded the lowest values for all the composite indices considered. The Centre Region occupies an intermediate position across all three indices.

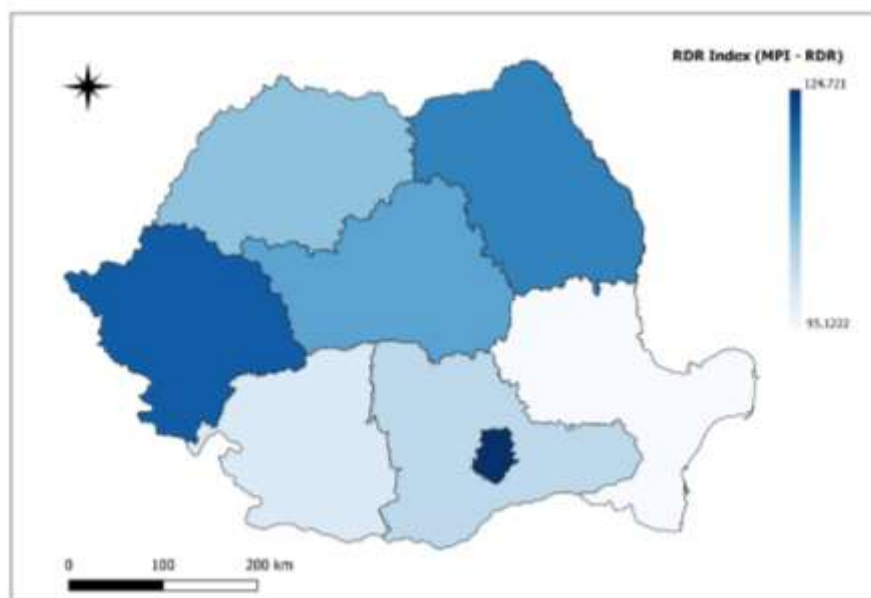


Fig. 2 Research and Development Resources Index (MPI RDR) – average value for the period 2004–2024

Source: Authors' own elaboration based on data from the Romanian National Institute of Statistics and the Ministry of Education and Research.

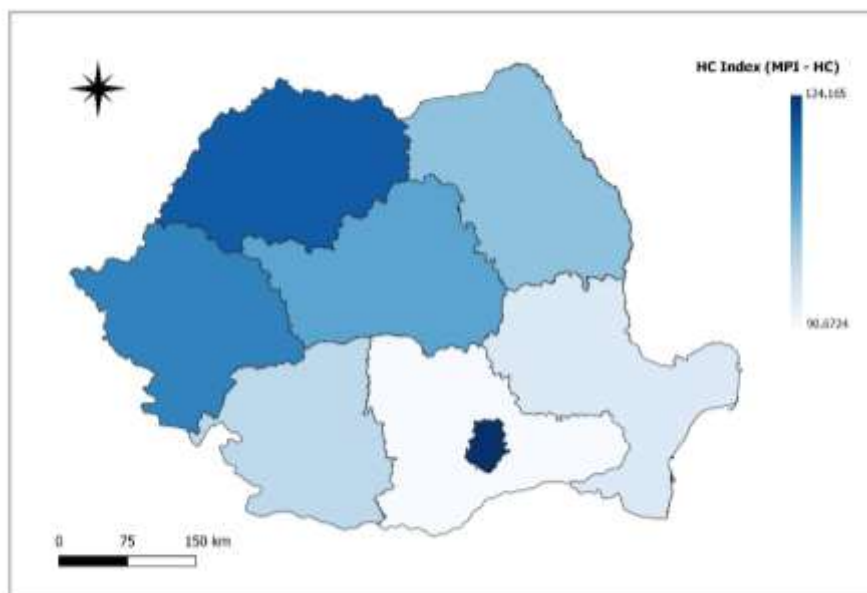


Fig. 3 Human Capital Index (MPI HC) – average value for the period 2011–2024

Source: Authors' own elaboration based on data from the Romanian National Institute of Statistics and the Ministry of Education and Research.

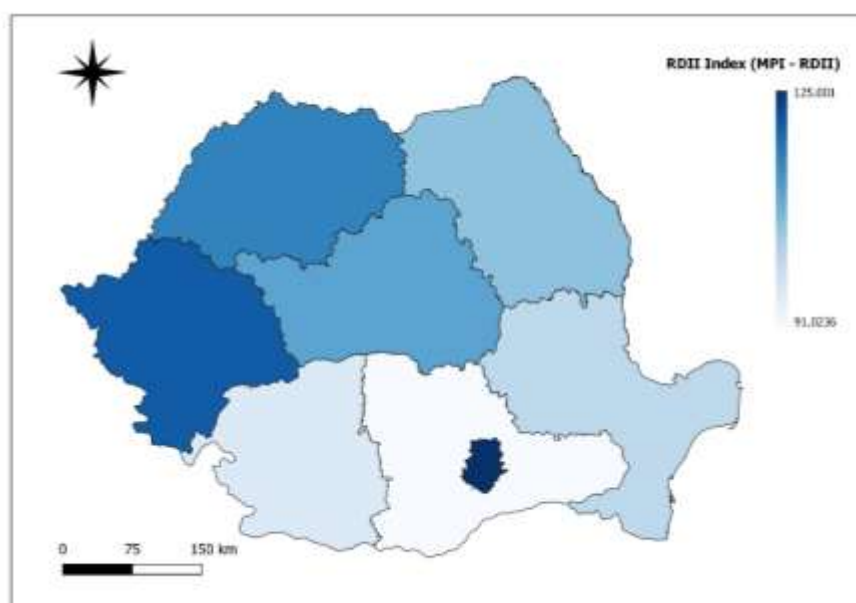


Fig. 4 Research, Development and Innovation Infrastructure Index (RDII) value in 2024

Source: Authors' own elaboration based on data from the Romanian National Institute of Statistics and the Ministry of Education and Research.

The detailed values of the composite indices for each region are presented in Table 2, which also indicates the positions occupied by the eight development regions in the corresponding rankings. In these rankings, position 1 denotes the region with the highest index value, whereas position 8 denotes the region with the lowest value. The maximum ranking difference represents the largest absolute difference among the three ranking positions assigned to each region.

Table 2. MPI values for Romanian development regions by composite index

Development region	MPI RDR	Rank	MPI HC	Rank	MPI RDII	Rank	Maximum rank difference
Bucharest-Ilfov Region	124.721	1	124.165	1	125.001	1	0
West Region	101.268	2	101.049	3	100.350	2	1
North-East Region	97.244	3	95.330	5	96.315	5	2
Centre Region	96.794	4	97.722	4	97.088	4	0
North-West Region	96.539	5	102.815	2	99.062	3	3
South-Muntenia Region	96.066	6	90.672	8	91.023	8	2
South-West Oltenia Region	93.897	7	94.518	6	94.880	7	1
South-East Region	93.122	8	93.546	7	95.952	6	2

Source: own calculations based on the composite MPI results.

A relatively strong correspondence among the indices can be observed for regions such as Bucharest–Ilfov and West, both of which recorded values above 100 for all the dimensions considered. By contrast, the correspondence is weaker in the North-West Region, where the HC Index exceeds 100, while the results for the other two indices place the region fifth and third, respectively, in the corresponding rankings. A relatively strong degree of consistency can also be observed among the indices for the regions occupying the bottom three positions: the South-East Region, the South-West Oltenia Region, and the South-Muntenia Region.

The results of the analysis of variables associated with research, development, and innovation are broadly consistent with the findings of other studies examining regional disparities from an economic perspective. In this regard, the 2025 Country Report prepared by the European Commission shows that, between 2013 and 2022, labour productivity in Romania recorded sustained growth in the capital region, amounting to 6.2%, followed by the West Region, with an increase of 5.2%. The lowest growth rates were recorded in South-West Oltenia and South-Muntenia, at 0.6% and 0.5%, respectively, while the North-East Region experienced a 0.5% decline in productivity. With regard to GDP per capita, Romania achieved sustained convergence, increasing from only 30% of the EU-27 average in 2002 to a record level of 78% in 2023. However, this convergence conceals substantial regional disparities, with the Bucharest–Ilfov Region reaching 190% of the EU average in 2023. In 2024, the unemployment rate ranged from only 2.2% in the capital region to 9.9% in the South-East Region. Gender disparities were also evident: in 2023, only approximately half of women aged between 20 and 64 were employed in the South-East Region, compared with 76.6% in Bucharest–Ilfov [24].

Persistently low levels of investment in research and development, combined with weak innovation performance, further reinforce regional inequalities. At the national level, business expenditure on research and development remained below the EU average of 1.53% in all Romanian regions, while the national average stood at only 0.29%. In 2024, the share of employment in high-technology sectors exceeded the EU average of 5.2% only in Bucharest–Ilfov, where it reached 9.2%, and in the West Region, where it stood at 6.0%. In the remaining regions, the corresponding share ranged from only 0.8% to 3.4%, highlighting the limited diffusion of technology-intensive employment beyond the country’s most economically advanced regions [24].

4. Conclusions

The present study examines regional disparities in Romania from the perspective of research and development resources, higher-education-related human capital, and the availability of research, development, and innovation infrastructure. Subject to the availability of public data for each variable considered, the analysis covered different periods within the 2004–2024 interval and was conducted by calculating composite indices for each of Romania’s eight development regions. The results revealed a substantial gap between the Bucharest–Ilfov Region and the other development regions across all three dimensions, a disparity that has also been identified by studies focusing on regional economic performance.

The findings also indicate that regional differences are not limited to the dominant position of Bucharest–Ilfov. The West Region recorded comparatively favourable results across the dimensions considered, while the Centre Region generally occupied an intermediate position. By contrast, the South-East, South-Muntenia, and South-West Oltenia regions consistently recorded some of the lowest composite index values.

From a policy perspective, the results support the need for differentiated regional interventions rather than uniform national measures. Regions with weak research and innovation capacity require not only additional financial resources, but also stronger institutional infrastructure, improved cooperation between universities, research institutes, public authorities, and firms, and more effective mechanisms for retaining highly qualified graduates and researchers.

The study is subject to several limitations. First, the availability and temporal coverage of the data differed across the three composite dimensions, with the Research, Development and Innovation Infrastructure Index being calculated only for 2024. Second, the indicators included in the analysis predominantly measure resources, educational participation, and institutional capacity rather than direct innovation outputs. Third, the annual standardisation procedure captures the relative position of each region within the national regional distribution and does not directly measure absolute progress over time. Moreover, the results may be influenced by the exceptional position of Bucharest–Ilfov within a sample comprising eight development regions.

Future research could extend the analysis by incorporating innovation-output indicators, such as patent applications, innovative enterprises or scientific publications. Further studies could also examine the relationship between these composite indices and regional economic outcomes, including productivity, GDP per capita, employment, and business formation.

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