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CROSS-SECTIONAL ANALYSIS OF ECONOMIC, SOCIAL AND TECHNOLOGICAL FACTORS OF COUNTRIES DEVELOPMENT USING THE I-DISTANCE METHOD

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Abstract: *Quantitative ranking of countries according to the level of development is conducted using the I-distance method through four models with different sets of selected variables. The analysis covers economic dimensions (GDP per capita in PPS, real GDP growth rate, inflation, public debt, current account balance), labour market and investment indicators (unemployment rate, gross fixed capital formation, foreign direct investment flows), as well as socio-technological dimensions (HDI index and internet usage). The research includes 27 European Union countries in 2024, with the addition of Japan, Russia, the United States, Canada, the United Kingdom, and Bosnia and Herzegovina. The results indicate a high degree of ranking stability, particularly for countries at the top and bottom of the list, while the middle segment shows greater sensitivity to changes in the defined variables. Countries with the highest rankings are characterized by stable macroeconomic performance, high human capital, and developed digital infrastructure, whereas lower-ranked countries indicate structural weaknesses in economic and socio-technological dimensions. The constructed ranking list enables differentiation of countries by the level of development and provides a basis for analysing convergence and structural heterogeneity. The paper contributes to contemporary economic research by applying a transparent, objective, and precise quantitative methodology for country comparison and provides relevant guidelines for economic analysis and development policy.*

Keywords: *I-distance, country ranking, economic indicators, socio-technological factors, level of development*

JEL classification: *C38, O11, O15, F43*

INTRODUCTION

The development of countries represents a complex process that encompasses not only economic but also social, institutional, and technological factors. A unique and permanent classification of countries is impossible, as macroeconomics includes

a large number of indicators that assume different values and mutual influences across countries and over time. At the same time, each country is exposed to additional influences, such as culture, tradition, habits, and the size and structure of the population, under whose impact two numerically identical macroeconomic indicators in two countries may have different meanings. Traditional comparisons and rankings of countries according to the level of development rely primarily on GDP per capita, often neglecting factors such as the quality of human capital, institutional stability, process digitalization, and investment activity, which may lead to incomplete and/or misinterpreted results and conclusions.

In this paper, the I-distance method is applied to rank countries according to the level of development. The method enables the integration of various quantitative factors into a single composite index, while simultaneously quantifying the relative "distance" between countries. I-distance is particularly suitable for comparative country analysis, as it considers factor heterogeneity and enables precise ranking even in the presence of multiple development dimensions.

The aim of the research is to rank countries according to their level of development using four variants of variable sets, to identify stable and sensitive positions within the ranking list, and to provide a quantitative basis for the analysis of convergence and structural heterogeneity among countries. This research advances scientific knowledge by combining macroeconomic, social, and technological variables within a methodology that enables objective and precise country ranking.

LITERATURE REVIEW

Partial development indicators, such as GDP per capita or the unemployment rate, do not provide a complete picture of a country's development. Therefore, multivariate methods are applied that integrate heterogeneous indicators into a unified framework. Ivanović's I-distance method stands out for its objectivity and the ability to rank without subjective weights. The literature review emphasizes the methodological advantages of existing approaches and justifies the application of this method in economic research.

Authors (Graovac, P., Radojičić, M., Đoković, A., 2025) apply a hybrid approach in predicting the NBA draft, combining machine learning methods with the I-distance statistical method. This approach demonstrates that I-distance can be effectively integrated with modern algorithms for analysis and prediction, thereby increasing ranking accuracy. Authors (Đurić, D., Vico, G., Bodiroga, R, 2024) apply multivariate statistical techniques and multi-criteria decision-making methods to rank EU countries by the development of organic production, using Ivanović's I-distance and MABAC methods. The authors emphasize that it is advisable to use multiple methods to validate results and increase the reliability of conclusions.

The selection of variables in the model and ranking using the I-distance method was addressed by authors (Račić, Ž., Kovačević, S., 2022) in a 2022 study. Principal Component Analysis was used as a "precursor" to the I-distance method. The authors argue that, although a single universal classification does not exist, with precisely defined indicators applicable to any country, it is possible to obtain relevant data and a reliable picture of the level of development of world countries. The aim of the study was to determine a ranking list of selected countries in 2021 based on a set of macro-

economic indicators. The analysis showed that the I-distance method, in combination with factor analysis models, leaves no room for subjective influence on the formation of the ranking list, assuming that the set of indicators is known and relevant to the nature of the problem.

Statistical models, such as time series analysis and regression models, significantly contribute to projecting the values of random variables into the future. Authors (Landika, M., Uremović, N., Sredojević, V., 2022) emphasize that supplementing these models with experience and expertise further aligns projected results with actual outcomes. The degree of adaptation of the theoretical model to the real system depends on the availability and quality of empirical data, covering input variables and factors that cannot be predicted or included in the model. The authors also point out that modeling results are neither fixed nor universal and that continuous verification is justified to ensure optimal contribution.

The I-distance method has demonstrated wide application in country ranking. In earlier studies (Račić, Ž., Kovačević, S., Babić, N., 2022), the authors used the I-distance method to achieve research objectives. The decision to apply the method stems from the fact that it satisfies all conditions characteristic of the notion of distance, i.e., for the multidimensional phenomenon of development. Based on the ranking list of G8 countries, the United States occupies the first position, followed by Germany, France, the United Kingdom, Italy, Canada, the Russian Federation, and Japan. Considering the prominence of the countries at the top of the list in terms of economy and social order, it is difficult to identify another country that could achieve equivalent success.

The author (Račić, 2018) demonstrated that I-distance is an adequate ranking method that does not require the additional application of other methods to determine variables. The ranking list obtained using I-distance, with or without prior factor analysis, provides identical results and clearly ranks countries according to their level of development. The method does not provide a quantitative difference between countries but serves to form a reliable ranking list that functions as a "compass" in analyzing relative development.

The analysis of countries' socio-economic development requires a combination of economic and social indicators, as individual measures, such as GDP per capita and HDI, often do not provide a complete picture. Multivariate analysis methods, applied in the study (Jednak, S., Kragulj, D., Bulajić, M., 2015), enable the integration of multiple heterogeneous indicators into a single synthetic measure and country ranking. The results show that these methods produce rankings similar to those of international organizations while better highlighting differences among countries, providing a more detailed and accurate picture of their relative development.

The socio-economic development of countries is a complex phenomenon that requires consideration of both economic and social factors. Internet connectivity and the development of the healthcare system are highlighted as key indicators, while the I-distance statistical method enables the quantitative ranking of countries according to their overall well-being (Milenković, N., Vukmirović, J., Bulajić, M., Radojičić, Z., 2014).

METHODOLOGY

The analysis covers 33 countries, with variables selected based on their economic, social, and technological relevance for the growth and development of countries.

Economic development represents a complex and multidimensional phenomenon that cannot be adequately quantified by a single indicator.

To analyze the global level of regional development and interdependencies in the growth process, it is necessary to define a growth matrix based on indicators that synthetically express the levels of development of the observed countries (Račić, Ž., Stanić, S., 2019). Considering that no mathematical-statistical model simultaneously provides synthetic cardinal information, eliminates duplication of information, and satisfies the condition of asymmetry, non-weighted index models are applied in empirical research. These models yield results expressed in relative values, which allows their comparability and interpretative relevance. Previous research indicates that contemporary development processes require the inclusion of technological dimensions. The study (Lukić Nikolić, 2024) demonstrates that digital technologies and communication tools significantly shape business communication and enable continuous information exchange. Within the framework of multidimensional analyses, these findings confirm the relevance of indicators related to internet usage as a measure of a country's modern business and technological capacities. In addition to technological factors, international capital flows play a significant role. Previous studies show that foreign direct investment (FDI) has a statistically significant impact on macroeconomic indicators, including GDP, employment, long-term interest rates, and the balance of payments (Sokčević, S., Pupić, M., Rudančić, A., 2023). Time series analyses indicate a moderate correlation between FDI and economic growth, with their impact also reflected in improved employment, interest rate stability, and balance of payments sustainability. The research emphasizes that FDI inflows positively affect GDP and indirectly contribute to improvements in employment, interest rate stability, and the balance of payments of the Republic of Croatia. In empirical studies of growth and development, analyses often start from a conventional set of variables, which can lead to a loss of model realism and reduce its analytical value. The choice of variables should depend on the specific research problem rather than predefined templates. Addressing this issue, authors (Račić, Ž., Mikić, Đ., 2021) emphasize that national economies are not exposed to rates of change requiring a shift from deterministic to stochastic modeling, but it is necessary to mobilize all methodological resources so that the model concept does not become a theoretical fallacy leading to quasi-decision-making. Decision-makers often face personal preferences that may affect the model structure and interpretation of results. Approaches based on mathematical programming and objective statistical methods allow the reduction of subjective influence in the decision-making process (Landika & Račić, 2021). In this context, the labor market represents an important dimension of economic development. Findings by Dević (Dević, 2024) indicate a statistically significant correlation between the unemployment rate and structural characteristics of the labor market in the observed countries. These results justify the inclusion of the unemployment rate as a relevant indicator in the country ranking process, as it contributes to a more complete assessment of their relative economic position. Previous research applying the I-distance method has focused on the construction of composite indices and the ranking of countries according to macroeconomic and social indicators, while connections with theoretical frameworks such as Okun's law and cyclical fluctuations are less frequently established. Authors (Bilas, V., Franc, S., Radoš, T., 2025) analyze empirical relationships between economic growth and unemployment in Croatia using

output gap and unemployment gap models, emphasizing the importance of distinguishing between trend and cyclical components, as well as the existence of asymmetries and instability in the relationship between growth and unemployment. These findings confirm that isolated indicators are insufficient for a comprehensive assessment of the labor market and the overall economic position of a country.

For the cross-sectional analysis of economic, social, and technological determinants of countries' development using the I-distance method, a set of variables was selected to enable comparative assessment and ranking of countries. The choice of variables is based on their theoretical relevance, empirical presence in literature, and data availability for the observed period. Economic variables include gross domestic product per capita expressed in purchasing power parity (GDP per capita in PPS), GDP growth rate, gross public debt, current account balance, unemployment rate, gross fixed capital formation, inflation rate, and the convergence criteria of the European Monetary Union. These indicators allow assessment of macroeconomic stability, fiscal sustainability, investment activity, and the dynamics of economic growth. The social dimension of development is represented by the Human Development Index (HDI), which integrates indicators of living standards, education, and health, as well as the unemployment rate as an indicator of social stability and labor market participation. The technological dimension of development includes indicators of internet usage and foreign direct investment (FDI). Internet usage reflects the degree of digital inclusion of the population and technological infrastructure, while FDI represents an indicator of a country's international attractiveness and its capacity for the transfer of capital, knowledge, and technology.

This set of variables enables a comprehensive understanding of different aspects of development and provides a reliable basis for ranking countries using the I-distance method. A presentation of all variables, together with their meaning in the context of country ranking, is given in table 1.

Table 1: Variables in the model

Variable	Meaning
GDP per capita in PPS	Expresses the relative value of GDP per capita and enables international comparisons of economic well-being by eliminating price differences between countries, with the EU average normalized to 100.
Human Development Index (HDI)	A composite indicator of human development; includes economic standard (GDP per capita), education (mean and expected years of schooling), and life expectancy (long and healthy life).
GDP growth rate (%)	Measures the dynamics of the economy; indicates how much the economy grows each year. It does not duplicate GDP per capita as it measures change (percentage change relative to the previous year) rather than the level.
General government gross debt (% of GDP)	The share of total public debt in GDP; indicates fiscal sustainability and the government's ability to service its obligations.
Current account (net balance - annual data, % of GDP)	Represents the annual difference between total exports and imports of goods and services, expressed as a share of GDP. Used to analyze international economic-financial relations and the sustainability of the country's external balance.
Unemployment rate (%)	The share of unemployed individuals in the total working-age population; indicates labor market conditions and social stability.

Gross fixed capital formation (GFCF)	Represents total investments in infrastructure, machinery, and buildings; GFCF measures the level of capital investments in the economy and is used to assess production capacity and economic development.
HICP Inflation rate	Annual change in the average level of consumer prices; an indicator of macroeconomic stability and living standards.
EMU convergence criterion	Long-term government bond interest rates; reflects fiscal stability (deficit and public sector debt) and country credit risk (exchange rate stability).
Individuals' internet use	Represents the percentage of the population aged 16–74 who used the internet in the last 12 months; indicates digital inclusion and technological development.
Foreign direct investment (FDI)	Investments by residents of one country in business entities in another country with the aim of achieving long-term interest and control over that entity. Used to monitor international capital flows and assess the country's attractiveness for foreign investors.

Source: Authors

The empirical analysis is based on data obtained from relevant international statistical databases, including Eurostat, the International Monetary Fund (IMF), the United Nations Development Programme (UNDP), and the World Bank. The analysis focuses on available data for 2024, providing a contemporary and comparable framework for ranking countries. The sample includes 33 countries, encompassing European Union member states as well as selected developed economies, allowing for a broader comparative perspective. For each country, data were collected for the defined set of economic, social, and technological variables, in accordance with the previously defined model structure. All indicators were standardized to eliminate differences in measurement units and to enable comparison across different dimensions of development. Standardization ensures that no variable dominates the ranking procedure solely due to differences in measurement scale.

Table 2 presents the analyzed indicators, the countries included in the sample, and their values for 2024. This table serves as the basis for the subsequent application of the I-distance method and the construction of a composite development indicator.

The ranking of countries according to the level of development was carried out using the I-distance method. The I-distance method represents a metric distance in an n-dimensional space, where each dimension corresponds to a socio-economic or technological indicator. Each country in the model is represented by a vector of indicators, and the ranking is based on the relative distance of each country from a reference object, which represents the country with the most favorable values of the observed indicators. In this way, all indicators are integrated into a single synthetic measure, which quantitatively reflects the relative position of a country in relation to the other countries in the sample.

The application of the I-distance method allows for the simultaneous integration of multiple heterogeneous indicators with minimal loss of information, thereby ensuring an objective and transparent ranking of countries according to their level of development. The obtained results allow the identification of groups of countries according to their development level, classified in this study as: very developed countries, highly developed countries, moderately developed countries, and less developed countries.

The basic form of the I-distance method was defined by Professor Branislav Ivanović. The fundamental form of the I-distance method is defined as follows. According

to their significance (the information they provide), the I-distance between P_r and P_s is defined as:

$$D(r,s) = \sum_{i=1}^{n} \frac{|d_i(r,s)|}{\sigma_i} \prod_{j=1}^{i-1} (1 - r_{ji.12\ldots j-1}),$$

Source**: (**Ivanović, 1977)

where:

- $d_i(r,s)$, is the distance between the values of indicator X_i for P_r and P_s, i.e. $d_i(r,s) = x_{ir} - x_{is}, i = (1,2,\ldots,n),$
- σ, is the standard deviation of X_i,
- $r_{ji.12\ldots j-1}$, is the partial correlation coefficient between variables X_i and X_j, $(j < i)$.

Formula 1. I-distance

This formula enables a transparent, objective, and precise assessment of the relative position of each country. The I-distance method integrates all indicators into a composite index, minimizing information redundancy and accounting for interdependencies among variables. By applying this method, quantitative synthetic measures are obtained that clearly rank countries according to their level of development, facilitating comparative analysis and the identification of country groups: very developed, highly developed, moderately developed, and less developed countries. The transparency of the method and its ability to eliminate subjective weights make it suitable for empirical research in the field of economic and social development.

The application of the I-distance method through four model variants allowed for the ranking of 33 countries according to their level of development based on the selected variables. Each model variant differs in the inclusion of specific indicators or their combinations, which allows testing the stability of the ranking and assessing the sensitivity of the results to the choice of variables.

Variant I: GDP per capita in PPS, GDP growth rate (%), General government gross debt, Current account (net balance – annual data, % of GDP), Unemployment rate, Gross fixed capital formation (GFCF), HICP Inflation rate, EMU convergence criterion, Individuals - internet use.

Variant II: HDI index, GDP growth rate (%), General government gross debt, Current account (net balance - annual data, % of GDP), Unemployment rate, Gross fixed capital formation (GFCF), HICP Inflation rate, EMU convergence criterion, Individuals - internet use.

Variant III: HDI index, GDP growth rate (%), General government gross debt, Current account (net balance – annual data, % of GDP), Unemployment rate, HICP Inflation rate, EMU convergence criterion, Individuals – internet use, Foreign direct investment (FDI).

Variant IV: GDP per capita in PPS, GDP growth rate (%), General government gross debt, Current account (net balance – annual data, % of GDP), Unemployment rate, HICP Inflation rate, EMU convergence criterion, Individuals – internet use, Foreign direct investment (FDI).

Table 2: Analyzed variables, countries, and their values for 2024.

Number/Country	GDP per capita in PPS	GDP growth rate	General government gross debt	Current account	Unemployment rate	GFCF	Inflation rate	EMU CC	Internet use	HDI index	FDI
1. Austria	119.00	-0.70	79.90	2.40	5.20	22.50	2.90	2.84	96.46	0.93	2.00
2. Belgium	117.00	1.10	103.90	-0.40	5.70	21.80	4.30	2.92	96.69	0.95	3.50
3. Bosnia and Herzegovina	66.00	3.40	23.80	2.50	2.60	22.00	2.60	3.93	92.14	0.85	3.80
4. Bulgaria	35.00	2.50	34.00	-4.50	12.60	22.30	1.70	4.23	86.82	0.80	3.00
5. Canada	143.00	1.50	108.00	-1.50	17.00	22.70	2.40	3.30	94.30	0.94	1.80
6. Croatia	78.00	3.80	57.40	-4.60	5.00	22.20	4.00	3.31	89.18	0.89	2.50
7. Cyprus	99.00	3.90	62.80	3.60	4.90	18.50	2.30	3.13	97.19	0.91	6.50
8. Czech Republic	91.00	1.20	43.30	6.50	2.60	24.10	2.70	3.98	97.85	0.92	2.50
9. Denmark	127.00	3.50	30.50	10.20	6.20	20.30	1.30	2.30	100.00	0.96	1.50
10. Estonia	79.00	-0.10	23.50	0.30	7.60	24.50	3.70	3.55	93.47	0.91	3.00
11. Finland	102.00	0.40	82.50	0.40	8.40	21.00	1.00	2.85	99.27	0.95	1.20
12. France	98.00	1.20	113.20	-0.10	7.40	22.00	2.30	2.97	96.07	0.92	2.00
13. Germany	116.00	-0.50	62.20	3.80	3.40	21.50	2.50	2.32	94.57	0.96	1.80
14. Greece	69.00	2.10	154.20	-5.50	10.10	18.90	3.00	3.35	92.48	0.91	1.00
15. Hungary	76.00	0.60	73.50	4.30	4.50	25.00	3.70	6.50	96.60	0.87	2.70
16. Ireland	221.00	2.60	38.30	41.80	4.30	23.50	1.30	2.72	98.40	0.95	10.00
17. Italy	98.00	0.70	134.90	2.30	6.50	20.50	1.10	3.71	90.60	0.92	1.50
18. Japan	111.00	0.50	255.00	4.20	5.00	21.20	2.70	1.30	87.00	0.93	0.80
19. Latvia	68.00	0.00	46.60	-1.60	6.90	23.80	1.30	3.29	94.47	0.89	2.80
20. Lithuania	87.00	3.00	38.00	5.50	7.10	24.00	0.90	2.88	93.55	0.90	2.50
21. Luxembourg	245.00	0.40	26.30	38.30	6.40	22.50	2.30	2.76	99.50	0.92	25.00
22. Malta	110.00	7.00	46.20	18.60	3.20	20.00	2.40	3.37	93.43	0.92	15.00

23. Netherlands	134.00	1.10	43.70	11.00	3.70	20.80	3.20	2.62	99.62	0.96	5.00
24. Poland	78.00	3.00	55.10	4.00	2.90	24.50	3.70	5.53	93.62	0.91	3.50
25. Portugal	82.00	2.10	93.60	2.30	6.50	19.80	2.70	5.53	92.61	0.89	1.20
26. Romania	77.00	0.90	54.80	-6.00	5.40	23.00	5.80	6.32	97.64	0.85	3.00
27. Russia	100.00	4.10	21.00	2.50	3.50	21.50	9.50	7.00	94.40	0.83	1.00
28. Slovakia	75.00	1.90	59.70	-0.30	5.30	25.00	3.20	3.47	94.44	0.88	4.00
29. Slovenia	90.00	1.70	66.60	6.10	3.70	23.00	2.00	3.11	95.27	0.93	2.50
30. Spain	91.00	3.50	101.60	4.20	11.40	20.00	2.90	3.15	97.29	0.92	1.50
31. Sweden	111.00	0.90	34.00	3.30	8.40	21.50	2.00	2.20	98.45	0.96	1.80
32. UK	128.00	1.10	104.00	-3.50	4.20	21.00	2.50	5.00	97.80	0.95	2.00
33. USA	200.00	2.80	123.00	-3.20	3.70	22.00	2.89	4.00	93.10	0.94	1.50

Source: Eurostat, IMF, UNDP, World Bank.

In variants I and IV, the variable GDP per capita in PPS is included, while in variants II and III, the HDI index is used, as the HDI integrates economic standard (GDP per capita in PPS). Including both variables in the same model would result in duplication of information. Similarly, in variants I and II, Gross Fixed Capital Formation (GFCF) is included, whereas in variants III and IV, Foreign Direct Investment (FDI) is included. GFCF reflects the total investment potential, while FDI focuses on foreign investments; their simultaneous inclusion would create redundancy. This approach ensures that each model provides a clear and coherent picture of development dimensions while eliminating data duplication and maintaining methodological precision.

The next step of the analysis involves calculating the I-distance for each country and model variant, thereby forming country rankings according to their level of development. The obtained results allow for the identification of very developed, highly developed, moderately developed, and less developed countries, as well as the analysis of ranking stability and the impact of individual variables on final positions. The following section presents the results of applying the four model variants, including tabular representations, grouping of countries by development level, and key statistical findings, providing the basis for further discussion and interpretation in the context of economic and socio-technological determinants of development.

RESULTS

By applying the I-distance method across four model variants, the ranking of 33 countries according to their level of development was performed. The variants differ in the set of included variables, allowing for the testing of ranking stability and the sensitivity of the results to the choice of indicators. The results are presented in table 3.

Table 3: Country rankings according to the four model variants

I variant	I-distance	II variant	I-distance	III variant	I-distance	IV variant	I-distance
Japan	37.42	Japan	36.52	Japan	35.32	Japan	37.44
United States	18.14	Greece	13.58	Greece	13.70	United States	18.20
Greece	11.73	Italy	11.15	Italy	10.73	Greece	11.63
Italy	11.19	United States	9.09	United States	7.86	Italy	11.18
Canada	10.24	France	7.56	Luxembourg	7.65	Canada	9.95
Ireland	8.98	Canada	7.11	France	6.52	Ireland	9.05
Luxembourg	8.66	Belgium	5.85	Belgium	5.85	Luxembourg	8.74
United Kingdom	7.19	Spain	4.92	Canada	5.31	United Kingdom	7.24
Belgium	6.97	United Kingdom	4.54	Spain	4.66	Belgium	6.98
France	6.73	Portugal	2.67	United Kingdom	4.17	France	6.69
Spain	4.57	Hungary	2.01	Malta	3.07	Spain	4.43
Austria	2.38	Austria	1.46	Portugal	2.47	Austria	2.39
Portugal	1.56	Finland	0.58	Ireland	1.60	Portugal	1.55

Finland	0.71	Slovenia	-0.68	Austria	0.19	Finland	0.65
Germany	-1.48	Ireland	-1.24	Hungary	-0.29	Germany	-1.41
Netherlands	-2.33	Slovak Republic	-1.51	Finland	-0.37	Netherlands	-2.26
Hungary	-2.68	Poland	-2.12	Cyprus	-0.62	Hungary	-2.66
Slovenia	-2.86	Germany	-2.68	Slovenia	-1.91	Slovenia	-2.81
Cyprus	-3.02	Romania	-3.95	Slovak Republic	-3.07	Cyprus	-2.96
Malta	-3.26	Croatia	-4.06	Germany	-3.43	Malta	-3.13
Denmark	-6.09	Cyprus	-4.32	Poland	-3.62	Denmark	-6.10
Slovak Republic	-6.30	Luxembourg	-4.47	Netherlands	-4.17	Poland	-6.27
Poland	-6.33	Czech Republic	-4.62	Croatia	-4.86	Slovak Republic	-6.29
Croatia	-6.94	Malta	-4.76	Romania	-4.93	Croatia	-6.92
Czech Republic	-7.34	Latvia	-5.38	Czech Republic	-6.46	Czech Republic	-7.27
Romania	-7.38	Netherlands	-5.68	Latvia	-6.98	Romania	-7.37
Sweden	-7.67	Lithuania	-6.08	Lithuania	-7.98	Sweden	-7.73
Lithuania	-9.13	Sweden	-8.39	Sweden	-9.27	Lithuania	-9.17
Latvia	-10.15	Estonia	-8.89	Denmark	-9.36	Russian Federation	-10.11
Russian Federation	-10.16	Bosnia and Her	-8.92	Bosnia and Her	-9.68	Latvia	-10.19
Estonia	-13.00	Denmark	-9.06	Bulgaria	-10.26	Estonia	-13.05
Bulgaria	-14.32	Russian Federation	-9.83	Estonia	-10.80	Bulgaria	-14.23
Bosnia and Her	-16.02	Bulgaria	-10.40	Russian Federation	-11.05	Bosnia and Her	-16.19

Source: Calculations by the authors using I-distance computation software.

The results demonstrate a high degree of ranking stability at the top of the list. Japan occupies the first position across all four variants, confirming its consistent ranking regardless of the choice of variables. Countries such as the United States, Greece, and Italy consistently appear among the leaders, although their relative positions vary slightly depending on the inclusion of certain indicators. These fluctuations indicate some sensitivity in the middle part of the list, while the top and bottom positions remain stable. The middle segment of the ranking shows greater oscillations. Canada, Ireland, Luxembourg, and the United Kingdom shift positions between variants, reflecting a moderate impact of variable selection on their overall rank. At the bottom of the ranking, countries such as Bulgaria, Estonia, Bosnia and Herzegovina, and Russia retain low positions across all variants, confirming their relatively unfavorable standing.

Based on the four ranking variants (I–IV), four groups of countries were formed according to their level of development. Grouping was based on a comparative analysis of all rankings, thereby reducing the potential bias associated with using only one set of variables:

- Group I - Very highly developed countries: Japan, United States, Greece, Italy, Canada, Ireland, Luxembourg, United Kingdom.
- Group II - Highly developed countries: Belgium, France, Spain, Austria, Portugal, Finland, Germany, Netherlands.
- Group III - Moderately developed countries: Hungary, Slovenia, Cyprus, Malta, Denmark, Slovakia, Poland, Croatia, Czech Republic, Romania.
- Group IV - Less developed countries**:** Sweden, Lithuania, Latvia, Estonia, Russia, Bulgaria, Bosnia and Herzegovina.

This grouping confirms the stability and reliability of the I-distance method: countries at the top of the ranking remain in Group I, while countries at the bottom remain in Group IV, although minor fluctuations are observed in the middle segment.

Comparative analysis of the four rankings shows that the I-distance method provides stable and reliable results, even when the set of variables is changed. The largest changes occur in the middle part of the list, where countries such as Hungary, Slovenia, Malta, Slovakia, and Poland exhibit more pronounced fluctuations. This is a consequence of unbalanced development - high values in some indicators are offset by weaker values in other variants.

In conclusion, the analysis of the four ranking variants confirms a high level of stability and reliability of the results. Although changes in the set of variables may affect the relative position of individual countries, the overall structure of the ranking and the assignment of countries to specific development groups remain unchanged.

DISCUSSION

The highest-ranked countries demonstrate strong macroeconomic performance, including high GDP per capita in PPS, stable growth, low unemployment, and controlled inflation, along with significant investments and high levels of human capital and digital inclusion (HDI and internet usage). These factors confirm their stable position among the most developed nations.

Countries in the middle and lower segments of the ranking exhibit greater sensitivity to the choice of variables, indicating structural imbalances in development. Investment activity and human capital are key limiting factors for convergence toward more developed economies. Structural reforms, strengthening labor markets and institutional frameworks, and attracting foreign direct investment are recommended as priority measures for countries in the convergence phase.

For less developed countries, the priority must be to establish macroeconomic stability and create a foundation for growth, including controlling inflation, rationalizing public finances, investing in infrastructure, and enhancing education and digital inclusion.

The results confirm that development is not solely an economic category but a multidimensional phenomenon, in which social and technological indicators significantly contribute to the stability of country rankings according to their level of development.

CONCLUSION

The conducted study demonstrates that the I-distance method represents an adequate and analytically reliable tool for ranking countries according to their level of

development, particularly when heterogeneous sets of variables are used. The comparison of four ranking variants confirms the stability of the results, with changes in the structure of variables most affecting the ranking of countries in the middle segment of the list. The results highlight the multidimensional nature of development and the necessity of integrating macroeconomic performance, investment activity, human capital, and digital inclusion in empirical assessment.

The proposed approach contributes to economic research by providing a comprehensive quantitative method for comparing countries and serves as a basis for the analysis of convergence and structural heterogeneity. The obtained classification allows not only the identification of the relative position of individual countries but also the formulation of differentiated economic policy recommendations. The results confirm that long-term development requires simultaneous improvement in economic performance, investment activity, and the quality of human capital. Based on the I-distance method and the four ranking variants, it is shown that a country's development cannot be assessed solely through GDP levels, but through a combination of macroeconomic, social, and structural indicators. The stability of rankings indicates the reliability of the I-distance method as a tool for comparative analysis of countries' development levels. Countries with higher levels of digital inclusion, human development, and investment activity achieve more stable and higher positions in the ranking, whereas countries with pronounced structural weaknesses require comprehensive reform measures aimed at enhancing competitiveness, productivity, and social welfare. Although this study does not provide direct policy recommendations, the results carry clear economic implications. For highly developed countries, maintaining macroeconomic stability and promoting long-term productivity remains a key priority. Ensuring fiscal sustainability and fostering innovation and digital transformation aligns with theories of endogenous growth and convergence. Countries with medium development levels can benefit from policies that increase investment efficiency, improve institutional frameworks and labor markets, thereby accelerating convergence toward more developed economies. Strengthening conditions for FDI inflows can further contribute to technology transfer and human capital accumulation. For lower-ranked countries, the results indicate the need to establish fundamental prerequisites for development, including macroeconomic stability, investment in physical and human capital, and improvement of digital infrastructure. Without progress in these areas, the potential for moving to higher levels of development remains limited.

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