



# I distance application in the ranking of Group 8 and European Union countries by level of development

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## Abstract

According to the analyses published by the international organizations, the most developed countries are those from Group 8. The group of highly developed countries is in matter, which consists of: Japan, USA, Russia, Great Britain, Italy, Germany, France and Canada. The goal of the work is to determine the ranking list of the selected countries according to the level of development in 2021 based on a certain number of macroeconomic factors. For the purposes of realizing the formulated goal, the I distance method was applied. A decision for the I distance method comes from the fact that this model satisfies all the conditions characteristic for the nature of distance, that is, for the multidimensional phenomenon of development. Based on the ranking list of Group 8 countries, the United States of America is in the first place, followed by Germany, France, the United Kingdom, Italy, Canada, the Russian Federation and Japan. Speaking about the EU countries, the Netherlands has the highest level of development according to the selected indicators, followed by Ireland, Belgium, Spain, Poland, Sweden, Austria, Denmark, Czech Republic, Luxembourg etc. The coming future will probably bring changes when it comes to the ranking on the ranking list. Changes can be expected due to the war events, demographic trends, technological achievements, and generally the replacement of the leading positions when it comes to resources. Namely, it is certain that the countries that adapt faster to other energy sources as well as to more economical use of the existing ones, will have a leading role on a global scale.

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## Introduction

Global processes, i.e. issues of growth and development of countries are hard to imagine today without the world's leading countries. Group 8 member countries (abridged G8) are elite when it comes to performances in global processes, i.e. in the effects of growth and development.

There are numerous problems modern economies are facing with. The war events in Ukraine (formerly in Syria) are currently present in the world, which caused or served as a trigger for the migration of people, which will probably have a long-term effect on changes in demographic structures and the level of economic development of countries in the world. Here, it is primarily referring to energy sources. It is certain that there is a substitute for oil, which is still the primary energy source. The issue of drinking water shouldn't be forgotten. The crisis in this field is deepening more and more. Therefore, the issue of climate is unavoidable. The G8 is a group of countries that are potentially the only ones capable of solving the mentioned problems.

In this paper, a ranking list of the G8 countries was formed according to the certain selected indicators of economic development. A single classification of countries according to the level of development is difficult to perform, taking into consideration that the very concept of the development of countries is complex and consists of several components. The mentioned components can be of economic, social and public profile. A successful economy (developed countries) is accompanied by an adequate social order, while in developing countries one or the other lags behind, and in countries that are not developed, none of the mentioned works. However, this statement is not necessarily true either. For example, in the Nordic countries, both the economy and social organization are developed at the same time, on the other hand, the USA is considered the most developed economy in the world, although the issue of social protection has been disputed in many cases.

According to analyses published by the World Bank, the most developed countries are those from Group 8 (abridged G8). Group 8 represents a group of highly developed countries, and includes: Japan, the USA, Russia, Great Britain, Italy, Germany, France and Canada.

Nowadays, under the pressure of war in the Ukraine, this informal organization excluded Russia from its membership. The successor of this group is Group 7. However, this act of behaviour does not eliminate Russian potential in the world economy. Institutions of a global character, such as the International Monetary Fund or the World Bank, have certain methods of classifying countries by level of development, which are based on methodologies such as comparison, i.e. comparing different indices or classic measures such as GDP and GDP per capita.

I distance method is a method of classification and ranking of multidimensional phenomena, based on the distance of values between the selected indicators. Selecting the I distance method comes from the fact that this model satisfies all the conditions characteristic for the nature of the distance, i.e. for the multidimensional phenomenon of development and as it gives the possibility of additional considerations through the standardized I distance, square I distance and I distance with grouped indicators. I distance method does not leave the possibility of subjective influence on the formation of the ranking list, assuming that the set of indicators is known and that it has all the properties that correspond to the nature of the problem.

Economic theory and practice do not know any unique set of indicators. The very complexity of this phenomenon relativizes any attempt to establish an unchanged

list of indicators. Therefore, the author's subjectivism is present in the field of choosing these indicators. What is the actual number of indicators remains to be seen in the concrete analysis, where their interdependence and the appearance of duplication should be taken into account, because these two facts directly affect the choice of the optimal number of indicators (Račić, 2018).

The question was raised to what extent the most commonly used indicators provide satisfactory information on the level of development and whether there might be some other characteristics and indicators that were unknown or neglected, and which could be even more significant than those that are most often taken into account. It was necessary to determine a relatively small number of well-chosen macroeconomic indicators that would contain the same level of information as if all possible indicators were used for the purpose of ranking countries in the world according to the level of development.

The subject of the research was the aspects or parameters that define the development of the countries observed on the example of the G8 members in modern conditions (as well as the EU countries).

The goal of this research was to rank countries based on the indicators (factors) that affect the level of development of the countries.

The main hypothesis of this paper was that the level of development of the G8 members and EU countries depends on the selected indicators for measuring the level of development. An auxiliary hypothesis is that the indicators that determine the development of G8 countries and EU countries represent aspects that underdeveloped countries must develop.

The chapters are structured as follows. The second chapter provides an overview of previous research on the ranking of various phenomena, specifically the I distance, as well as the indicators that were used in the research. The third chapter describes the I distance method. The fourth chapter analyse the data used in the model and the obtained research results. The discussion is expanded in the fifth chapter. Finally, the sixth chapter contains the main conclusions and recommendations for future activities and research.

## Literature review

There are numerous researches and studies that dealt with the ranking of various phenomena, specifically with the I distance method. Let's mention only the most important ones. The authors (Knežević et al., 2012) believe that the main advantage of the I distance method is the possibility of using more heterogeneous indicators that are taken into account when evaluating the effectiveness of the analyzed phenomena. The index obtained as an indicator of efficiency according to the I distance is relative one and depends on the number of indicators and analyzed units. At the same time, that index determines the ranking list according to the importance of the analyzed phenomena.

In their research (Maričić et al., 2016) they consider the values of the composite index should be first normalized before it is used in the model. Composite indices provide rankings and information on which decisions are made. However, some questions have recently arisen about the process of their development, especially in relation to the weighting process. The Composite I Distance Indicator (CIDI) methodology stands out as an unbiased method for assigning weights to indicators. The results obtained, which are grounded on data-based weights, can provide new insights into the nature of the observed ranking. The authors present an approach that could encourage further researches on the subject of composite index weights and rankings.

In their work (Janković et al., 2016) consider a set of CSD indicators (a set of indicators defined by the Commission for Sustainable Development - CSD, so they are called CSD indicators) in the countries of the European Union (EU-28). CSD indicators cover three aspects of sustainable development: economic, social and environmental. The aim of this work was to rank the EU countries according to the level of development. The statistical I distance method was used for that purpose. In the first step, significant indicators are distinguished and ranked according to the amount and importance of the information they provide for specific research. Subsequently, this method then converts the indicators into a single measure that reflects the level of development.

The paper (Račić, 2018) shows the process of ranking and classifying countries using the I distance method. The selection of indicators was made by analyzing the main components. By applying the I distance, the classification and ranking was performed on the basis of economic development with the use of macroeconomic indicators for selected European countries.

In their research (Calitz et al., 2021) deal with the indicators used to rank or measure the success of higher education institutions. A survey was conducted in order to determine the most relevant indicators for ranking universities considered by students, i.e. explores applicable indicators for ranking universities in South Africa, from the students' perspective.

The results show that students see resources and infrastructure, accreditation, international orientation, faculty quality, and teaching and learning as the most relevant indicators for university ranking. Recommendations are given to the university administration for defining the ranking indicators that the students rated as important.

Vidal and Ferreira (2020) also dealt with the indicators for ranking. In their research, they consider that although there are controversies about university ranking indicators, many universities are establishing strategies with the aim of adapting to those indicators and improving their positions. The authors conclude that the international ranking list of universities should not be a relevant source of information for considering the quality of universities because it can have a negative effect on the development of medium and long-term policies in higher education and the universities themselves. Universities should focus on their mission and provide valid and reliable information on the level of achievement of their goals.

Although it is not internationally recognized, the I distance method is widely used and accurate in determining the rank based on certain indicators. In view of the above, the advantages of the I distance method are great and represent the basis for further research in this area.

## Research methodology

For the purposes of the analysis, the indicators were selected in such a way that they reflect the real state of level of development. Development indicators are quantities that are usually expressed in different measures, and most often in monetary units - US dollars, percentages, kg or t, per inhabitant and similar.

Of course, the emergence of multiple measurement units leads to the development of the problem of unification, that is reducing the mentioned measures to a common measure, or making it possible to compare them. Therefore, the initial problem in the construction of appropriate operational classification models is to define the appropriate procedure for solving the problem of presence of different units of measure in which the indicators are expressed. However, the differences are significantly greater when approaching the construction of a synthetic indicator.

Disagreement comes from the fact that there are different starting points regarding the relationship between the selected indicators, such as: Whether to take the dependence between the indicators into account or not? Whether to eliminate the duplication of information about the level of development or not? Whether to declare all indicators as equally important or not? How to choose the region in relation to which the level of development of the observed regions will be measured? Whether and how to include a dynamic component in a synthetic indicator? The various questions that arose collectively shaped the models for calculating the synthetic indicator. All those models can be grouped in the following way: classification model based on the quotient of indicator values, classification model based on the distance of indicator values, regression analysis model, factor analysis model.

Neither of these models give a solution that has essential, cardinal, meaning which after an application can conclude what is the real difference between levels of development on observed countries. Hence, the application of these methods is limited to compiling a ranking list of countries according to the level of development, which can serve as a "compass" in the analysis of their development.

The model that stands out from the above is the one that implies classification based on the distance of the indicator values. This group includes those methods based on distances  $d_i(r, s), (1, 2, \dots, n)$ . Classification models based on indicator distance are: Steslicke-Mydlazska distance model, F distance model, Generalized distance model, I distance model. As it was already partially said, the I distance method was used in the research. The I distance method is probably based on more realistic assumptions than it is the case with all the methods mentioned so far, taking into account the scope of its application. The author of the model is prof. Branislav Ivanović (Ivanović, 1959). The basic form of the I distance method is defined in continuation. For the selected set of "n" indicators  $X = \{X_1, X_2, \dots, X_n\}$ , that are previously ranked by the importance (the information they provide), I distance between  $P_r$  i  $P_s$  is defined as:

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

where  $d_i(r, s)$  distance between indicators  $X_i$  for  $P_r$  and  $P_s$ ;  $\sigma$  is standard deviation from  $X_i$ ;  $r_{ji.12\dots j-1}$ : partial correlation coefficient between  $X_i$  and  $X_j$ , ( $j < i$ ).

The condition for using this method is the prior ranking of all indicators by importance. The construction of the I distance is iterative. The amount of individual information about the occurrence of development is taken as a criterion of significance. The indicator that is the first on the ranking list enters the value of the I distance with a weight of one. The individual information of such an indicator gives the most complete knowledge about the level of development. The second indicator has a weight of  $(1 - r_{12})$ . Part of the information on development provided by this indicator is already contained in the individual information of the first indicator. The third indicator in the row has a weight of  $(1 - r_{13})(1 - r_{23.1})$ . It is assumed here that part of its information about the level of development is contained in the individual information of the first and second indicators. Analogously, the procedure for determining weights for each indicator that is imposed as the next one is

conducted (the procedure repeats for all indicator that are analysed). The I distance defined in such a way satisfies all 13 conditions, which according to Ivanović (1959), one distance should satisfy. While using this method, corrections that significantly improved it were made, deviating partially from the original construction.

## Analysis and results

When choosing the indicator that was used for the purpose of creating the ranking list, the data of the World Bank, i.e. the list of indicators that it publishes, were used as the primary source. The observed group of countries refers to the G8 countries, which was primarily the target group in the work, and member countries of the European Union, along with Bosnia and Herzegovina. The G8 is an informal creation, while the EU is a tightly connected union, and BandH has a permanent aspiration to join the alliance of European countries.

The indicators that were singled out as necessary for the analysis of the economy, and which are used in the ranking itself, are: GDP, Reserves, Export, Balance, GDP per capita, FDI, Unemployment, Growth rate, and Inflation. Table 1 shows variables which are used in the model.

Table 1 Variables in the model

Variable name	Variable definition	Source
GDP	Gross domestic product (current US dollars, in billions)	World Bank; Economic statistics, 2021
Reserves	Total reserves (includes gold, current US dollars, in billions)	World Bank; Economic statistics, 2021
Export	Export of goods and services (current US dollars, in billions)	World Bank; Economic statistics, 2021; USA export of goods and services in 2021; <a href="https://www.bea.gov/news/2022/Japan_Export_of_goods_and_services_in_2021">https://www.bea.gov/news/2022/Japan_Export_of_goods_and_services_in_2021</a> ; <a href="https://knoema.com/atlas/Japan/Service-exports">https://knoema.com/atlas/Japan/Service-exports</a>
Balance	Current account balance (current US dollars, in billions)	World Bank; Economic statistics, 2021
GDP per capita	GDP per capita (current prices in US dollars)	World Bank; Economic statistics, 2021
FDI	Foreign development investments (current US dollars, in billions)	World Bank; Economic statistics, 2021
Unemployment	Unemployment rate	World Bank; Economic statistics, 2021; Unemployment rate USA; <a href="https://www.statista.com/statistics/263710/">https://www.statista.com/statistics/263710/</a>
Growth rate	Annual percentage growth rate of GDP per capita	World Bank; Economic statistics, 2021; Annual % growth rate of GDP Cyprus; <a href="https://www.bea.gov/news/2022/Russia_GDP_growth_rate">https://www.bea.gov/news/2022/Russia_GDP_growth_rate</a> ; <a href="https://www.bloomberg.com/news/articles/2022-02-18/">https://www.bloomberg.com/news/articles/2022-02-18/</a>
Inflation	Inflation rate, consumer prices (Annual percent change)	World Bank; Economic statistics, 2021

Source: Author's.

The values variables used in the model are presented as follows (table 2). By applying the I distance, and based on the macroeconomic indicators, a ranking list of countries according to the economic development was formed. A ranking list of the G8 countries was formed first, taking into account the selected indicators, and in the continuation of the work, the EU countries (including BandH) were also the subject of the ranking. Table 3 presents the ranking of the G8 countries by the level of economic development.

Table 2 The Values of macroeconomic indicators (in US dollars for 2021)

No.	Country / Indicator (2021.)	GDP (in billion)	Reserves (in billion)	Export (in billion)	Balance (in billion)	GDP per capita	FDI (in billion)	Unemployment	Growth rate	Inflation
1	Austria	477	34	267	-3	53268	7	6.30	4.02	1.74
2	Belgium	600	42	512	-2	51768	20	6.42	5.84	2.13
3	Bosnia and Herzegovina	23	9	10	-0.5	6916	-0.5	15.22	7.67	1.96
4	Bulgaria	80	39	51	-0.3	11635	-1	5.42	4.70	1.03
5	Canada	1991	107	611	1	52051	30	7.51	3.99	1.36
6	Croatia	68	28	35	2	17399	-3	8.68	14.66	0.47
7	Cyprus	28	2	22	-2	30798	-3	6.13	5.50	1.23
8	Czech Republic	282	174	205	-2	26378	-0.2	2.89	3.29	1.60
9	Denmark	397	82	237	33	67803	18	4.80	4.24	1.31
10	Estonia	36	2	29	-0.5	27281	0.4	6.33	8.37	2.69
11	Finland	299	17	116	2	53983	-6	7.53	3.25	2.13
12	France	2937	244	880	-18	43519	-17	8.06	6.77	1.34
13	Germany	4223	296	2004	314	50802	120	3.54	2.93	0.34
14	Greece	216	14	88	-13	20277	-5	14.80	8.70	1.38
15	Hungary	182	43	148	-5	18773	-2	4.12	7.54	1.43
16	Ireland	499	13	672	70	99152	46	6.63	12.52	2.08
17	Italy	2100	227	687	53	35551	4	9.83	7.34	1.15
18	Japan	4937	1406	170	142	39285	123	2.80	2.09	2.45
19	Latvia	39	5	25	-1	20642	-2	7.60	5.44	1.79
20	Lithuania	65	6	53	0.9	23433	-1	7.90	4.99	2.35
21	Luxembourg	87	3	184	4	135683	94	5.23	5.44	0.75
22	Malta	19	1	26	-1	33257	-11	3.50	9.09	2.08
23	Netherlands	1018	64	851	97	58061	110	4.01	4.49	3.68
24	Poland	674	166	411	-4	17841	-25	6.65	6.06	1.37
25	Portugal	250	33	105	-3	24262	-9	5.17	4.86	1.12
26	Romania	284	52	116	-20	14862	-9	5.01	6.67	3.72
27	Russian Federation	1776	632	548	122	12173	25	6.74	4.50	2.06
28	Slovak Republic	115	10	108	-2	21088	0.3	4.42	3.24	1.13
29	Slovenia	62	2	51	2	29201	-0.6	14.73	7.88	3.42
30	Spain	1425	92	498	13	30116	-11	8.66	5.21	2.93
31	Sweden	627	62	290	35	60239	-7	4.53	4.17	1.73
32	United Kingdom	3187	194	860	-83	47334	79	5.46	7.05	0.53
33	United States	22996	716	2281	-822	69288	52	5.5	5.55	1.17

Table 3 Ranking list of the G8 countries by the I distance

	Country	I distance
1.	United States	1516970907826.20
2.	Germany	1293970609659.12
3.	France	387763572355.17
4.	United Kingdom	371996835002.06
5.	Italy	232858400004.77
6.	Canada	171216341775.21
7.	Russian Federation	120261440622.10
8.	Japan	-184112112515.51

Source: Author's calculation.

The first position of the United States is noticeable, which in principle coincides with the achievements of its economy at the global level. In appearance, the position of the Russian Federation and Japan is surprising, but it should be taken into consideration that the structure of these economies is to some extent limited by the EU rules and regulations. In that context, the position of Russia is interesting. Although we are talking about a world power that has at its disposal the exceptional amounts of resources, its position is below its potential.

It is also interesting that the United Kingdom is in the middle of the ranking list of the G8 countries development and that it is ahead of Italy, Canada and the already mentioned Russian Federation and Japan. Perhaps this position is actually a positive sign for those who support its exit from the EU. Nevertheless, this is a possible explanation, but a deeper analysis is needed to be performed in order to actually reveal the true reason as well.

Table 4 The ranking list of countries by level of development

No.	Country	I distance (in billions)
1.	United States	1516.971
2.	Germany	1293.971
3.	France	387.764
4.	United Kingdom	371.997
5.	Netherlands	364.708
6.	Italy	232.858
7.	Ireland	220.607
8.	Canada	171.216
9.	Russian Federation	120.261
10.	Belgium	91.460
11.	Spain	79.944
12.	Poland	9.699
13.	Sweden	-87.248
14.	Austria	-106.034
15.	Denmark	-130.517
16.	Czech Republic	-155.997
17.	Luxembourg	-172.913
18.	Japan	-184.112
19.	Hungary	-201.661
20.	Finland	-227.274
21.	Romania	-227.614
22.	Slovak Republic	-234.247
23.	Portugal	-236.496
24.	Greece	-250.330
25.	Lithuania	-278.698
26.	Slovenia	-279.715
27.	Bulgaria	-280.356
28.	Croatia	-293.030
29.	Estonia	-297.598
30.	Malta	-300.568
31.	Latvia	-301.059
32.	Cyprus	-303.035
33.	Bosnia and Herzegovina	-312.953

Source: Author's calculation.

The ranking list in Table 4 is expanded in relation to Table 3 for the EU countries, as well as for BandH. Table 4 shows the ranking list of selected countries by level of development using the I distance method for the EU countries and the Group 8 countries.

## Discussion

Using the I distance method, for the selected indicators of economic development, the United States is in the first position of the ranking list of the development of the analyzed countries. The Netherlands and Ireland are in 5<sup>th</sup> and 7<sup>th</sup> place, respectively, and their position on the ranking list is between the G8 countries. We



also notice that Belgium, Spain, Poland, Sweden, Austria, Denmark, Czech Republic and Luxembourg are in the positions before Japan (from the G8 group of countries). What happened to Japan is hard to say, but according to these indicators, it was in 18<sup>th</sup> place among the analyzed countries in 2021. Perhaps it is a question of bad reactions of the economic policy in the era of the pandemic or it is a question of some structural problems, it is not known.

Based on the formed ranking list of countries and the I distance values, it is possible to divide the countries into 4 group of countries. The first group (the value of I distance above 30 billion US\$) consisted of the United States, Germany, France, the United Kingdom and the Netherlands (the most developed countries). The second group of countries (under 30 billion US\$ do 0 US\$) consisted of Italy, Ireland, Canada, Russian Federation, Belgium, Spain and Poland (developed countries). The third group of countries (from 0 US\$ to -300 billion US\$) consisted of Sweden, Austria, Denmark, Czech Republic, Luxembourg, Japan, Hungary, Finland, Romania, Slovak Republic, Portugal, Greece, Lithuania, Slovenia, Bulgaria, Croatia and Estonia (less developed countries). The fourth group of countries (rest of the countries) consisted of Malta, Latvia, Cyprus and Bosnia and Herzegovina (developing countries).

## Conclusion

It is expected that the result, i.e. the final order would have been different if we had included the rest of the world's countries, or at least the more developed ones such as the members of the "Asian Tigers" or the BRIC countries. However, taking into account the reputation of the countries that have positioned themselves at the top of the list when it comes to the economy and social order, it is difficult to single out another country that could achieve equivalent success.

It follows from this that it is necessary for the countries, which aspire to better positioning in the final ranking list, to develop the indicators that serve as the indicators for evaluating the level of development.

The coming future is likely to bring changes when it comes to the order of the ranking list of the level of development. Changes can be expected due to the war events, demographic trends, technological achievements, and generally the replacement of leading positions when it comes to the resources. Namely, it is certain that the countries that adapt themselves more quickly to the other sources of energy, as well as to more economical use of the existing ones, will have a leading role on a global scale.

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