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Process of ranking countries by level of development

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Abstract:
The paper presents the process of ranking and classifying countries using the I-distance method. The I-distance method is a method of classification and multidimensional ranking based on the distance values between selected indicators. The selection of indicators was carried out using the principal components analysis, whereby the statistical software SPSS (Statistical Package for Social Sciences), the latest version 21th PASW Statistics, is used. The application of the I-distance determines the relative efficiency indicators. Classification and ranking are conducted based on the economic development using macroeconomic indicators for the selected European countries.

Keywords: classification, EU countries, I-distance method, principal components analysis, ranking.

JEL classification: C10, C44, C88, F43.

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Introduction
Accomplishing the unique classification of countries according to the level of development is very difficult, given that the very concept of developing countries is complex and often covers many aspects, such as economic and social aspects. The need for such a classification is very emphasized, although there is no single classification with precisely defined criteria that can be applied to each country in order to provide relevant information and reliable picture of development of countries in the world. The method of I-distance combined with factor analysis models leaves no possibility of subjective influence on the formation of the ranking, assuming that a set of indicators is known and that it has all the characteristics corresponding to the nature of the problem. Modern theory defines development as a multidimensional and complex phenomenon, which is therefore impossible to measure with just one macroeconomic indicator, it takes the whole set of them. Today, different international organizations use different systems of countries classification. To assess the development of a country, the United Nations Development Program (UNDP) uses a complex HDI index (Human Development Index) (United Nation, 2018). The HDI index encompasses the dimension of health

(life span), the dimension of education and the dimension of income (measured by gross domestic product per capita). By analysing these dimensions, it is shown how people and their abilities influence the country's development estimation but not the economic growth itself. HDI uses the revenue algorithm, to show a decrease in the importance of revenue with an increase in national income. The results for the three HDI dimension indices are then collected in a composite index using a geometric mean. Based on this index, countries are divided into four groups: countries with very high, countries with high, countries with middle and countries with low human development (Nilsen, 2011). The World Bank classifies countries according to the GDP per capita. For 2016, low income countries are those with GDP per capita lower than $ 1,045; countries with a GDP per capita between $ 1,045 and $ 4,125 belong to lower middle income countries; an upper income ones which had GDP per capita between $ 4,125 and $ 12,746 and the high-income are those that have had GDP per capita over $ 12,746 (The World Bank, 2016). International Monetary Fund classifies countries as "advanced economies" and "emerging and developing economies". The term "emerging economies" refers to countries that have some characteristics of developed economies, but not yet at the per capita income level (Nilsen, 2011). This paper analyses countries of European Union (EU-28) as a whole and in particular each member state. Apart from the EU, this analysis also includes Switzerland, as one of the most developed countries in Europe. Turkey is also involved in analysis, given its significance in the Balkans.

Literature review

Numerous studies have been conducted that deal with ranking, namely I distance. Let us mention only the most relevant ones. In their research (Maričić et al., 2016), they believe that the values of the composite index need to firstly be normalized before they are used in the model.

Similar considerations could be found in the work, (Rauhvargers, 2013) where it is proved that besides ranking it is very important to deal with the problem of "normalization" of data but without mentioning what kind of normalization is implied.
Some authors (Janković Šoja et al., 2016) consider that the advantage of Method I distance is that it easily solves the problem of subjectivity in determining the significance of certain indicators. The disadvantage is that the method did not gain greater international significance (recognition). Although it is not internationally recognized, the method has a higher level of application and accuracy in determining the rank based on certain indicators.

In their research (Cracolici, Cuffaro, Nijkamp, 2010), a model for linking important economic and non-economic indicators into the logical framework is presented. The aim is to establish a model and determine the intensity and direction of the relationship between the economic and non-economic aspects of the functioning of a state.

The expansion of the previous studies is the work of (Koster, 2014), in which the author introduces an examination of individual attitudes (preferences) in relation to the interests of the state.

Given the above mentioned literature, the advantages of the method of I distance are great and are the basis for further research in this area.

Assessment of the countries development

The analysis of country development is the subject of many discussions and dilemmas from the standpoint used by the method to rank, on the one hand, and on

the other hand, how to choose a set of indicators and use them. Several indicators are used as a comprehensive indicator of the phenomenon analysed. The problem is the availability of official indicators. Eurostat is used as a source of data as it is considered to be an official "statistical data centre". Everything that was published as the most commonly used indicators are included in the analysis.

However, the question is, do the most commonly used indicators provide satisfactory information and may there be some other features and indicators that were unknown or neglected, which could be even more significant than those most commonly used in consideration? The limitation is also availability of such data.

It is necessary to determine a relatively small number of well-chosen macroeconomic indicators that would contain the same level of information as if I used all the possible indicators for ranking countries in the world according to the level of development.

If we have a larger number of indicators, it is necessary to simplify the classification of its elements through dimensional reduction. The choice of a set of indicators should provide such classification and ranking, which should not be statistically significantly different from the classification that would be made in case that all the initial set of indicators are taken into account.

It is necessary to proceed from a wider list of possible indicators, which will then be subjected to the analysis of significance in order to bring the initial list of indicators to an "optimal" measure. From a variety of indicators, nine indexes in the initial listing were listed. Let's mark them with X_1, X_2, ..., X_9, where:

X_1 – GDP (in EUR) is a common measure of economic activity represented by the overall value of products and services produced in a certain territory (usually one country) over a period of time (mostly 1 year) reduced for the value of raw materials and semi-products used for their production. This is the indicator most commonly used in analyses of this type.

X_2 - The volume index of GDP per capita (Index: EU28=100) in Purchasing Power Standards (PPS) is expressed in relation to the European Union (EU28) average which equals 100. If the index of a country is higher than 100, then level of GDP per capita is higher than the EU average and inversely. Basic figures are expressed in PPS. It is a common currency that eliminates the differences in price levels between countries that allows meaningful volume comparisons of GDP between countries (Eurostat, 2018b).

X_3 - Export of goods and services (in EUR) - Includes all transactions of goods and services from residents to non-residents. Exportation of goods and services has a positive impact on GDP through external trading multiplier and it shows how some companies in certain country are competitive in the foreign market.

X_4 - Import of goods and services (in EUR) - Includes all transactions of goods and services from non-residents to residents. Importation has a negative impact on GDP generation. It reduces the positive effects of export and increases dependence of a certain country of products from other countries.

X_5 - Public Debt (in EUR) - This indicator is defined as the Consolidated Gross Debt of Public Sector (the Maastricht Treaty), which was not settled at the end of the year and includes cash and deposits, debt securities and public sector loans.

X_6 - Deficit/surplus (in EUR), debt and correlated data. This indicator is defined as the net borrowing/lending of the government or the public sector in accordance with European accounting standards (the Maastricht Treaty).

X_7 - HICP - Harmonized Consumer Price Index - is the indicator of inflation rate and price stability of the European Central Bank. HICP is calculated as a weighted average of the price index of the member states in Euro zone. The primary goal of

the European Central Bank is to maintain price stability, which is defined as the growth maintenance of the HICP. Desirable values are below 2% in the middle term. This index is also used to determine the fulfilment of convergence criteria related to the inflation.

X_8 - Electricity prices by type of user (EUR per kWh). This indicator represents the price of electricity that is charged to end users.

X_9 - Unemployment rate - Represents the participation of unemployed people in the total work force based on the definition of the International Labour Organization (ILO). The total work force is a sum of employed and unemployed people, who are actively looking for a job, and are aged between 17 and 74 years.

The choice of indicators was made based on macroeconomic development indicators for 2017 available on the Eurostat website (Eurostat, 2018a). The selection of these nine indicators was subjective, conducted according to the available data and the significance of each indicator to the development of a country. Indicators are divided into two groups: economic and social. The order of inclusion and the number of indicators in the model represents a big problem for every researcher. In addition to that, all sciences are trying to illustrate and anticipate a large number of phenomena and further development based on a small number of indicators or samples. In order to minimize the subjectivism in the modelling process, Factor Analysis as a predecessor of method and distance is used. Specifically, factor analysis as an objective method, uses its algorithms and techniques to reduce the number of indicators and resume them to an optimal number. After the main factors formation, the method of I-distances to define the rank of countries according to the level of development is used.

Reduction of the indicators list - Principal Components Analysis

Although the Factor Analysis, and within it the Principal Components Analysis, emerged and developed in the context of psychology, it is basically a set of mathematical and statistical methods. Factor analysis belongs to a group of multivariate analysis techniques aimed at interdependence techniques. In these techniques all variable have the same status and enter the model equally i.e. there is no division between dependent and independent variable. Factor Analysis is a procedure used to reduce the original data space to a smaller number of dimensions. Factor analysis models are good precursors to I-distances models, as apart from providing an objective list of significance indicators, there are additional features of factor-based solutions. The aim of Factor Analysis is to identify a small number of indicators that are called factors. The point is to describe a great deal of information with smaller number of factors without losing any individual information.

Formal tests for justifiability of application Factor analysis is Bartlett`s test of sphericity and Kaiser-Meyer-Olkin sample adequacy measure as the KMO statistic. Factor analysis does not make sense if the Bartlett's test is not statistically significant.

Below (Table 1) the results of Bartlett's test and KMO statistics are shown. By analysing p-value (Sig.=0.000), it might be concluded that the zero hypothesis is rejected, which means that the analysis bay be continued.

Table 1 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.478
Bartlett's Test of Sphericity	Approx. Chi-Square	251.799
	Df	36
	Sig.	0.000

The following table gives the key information on how many factors, the database (Table 2) was reduced. We have information in it, such as: eigenvalues of the factors, eigenvalues represented as percentages of the total explained variance and cumulative percentages. Data for all factors are shown in the first three columns (Initial Eigenvalues), while in the remaining three columns (Extraction Sums of Squared Loadings) data is shown only for those factors that meet the criteria to be retained (this characteristic value is over 1).

The following table shows that the first factor explains 30.213% of the total variability of all 9 original variables, the second 20.342%, the third 18.355%, and the fourth 11.374%. It is important to emphasize that these four factors explain over 80% of total variability (which is enough to choose them as "representatives" of all original variables).

Table 2 Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1 GDP	2.719	30.213	30.213	2.719	30.213	30.213
2 GDP per capita	1.831	20.342	50.555	1.831	20.342	50.555
3 Export	1.652	18.355	68.910	1.652	18.355	68.910
4 Import	1.024	11.374	**80.284**	1.024	11.374	80.284
5 Public debt	.796	8.845	89.129			
6 Deficit/surplus	.585	6.503	95.632			
7 HICP	.360	3.999	99.630			
8 Electricity prices	.030	.336	99.966			
9 Unemployment rate	.003	.034	100.000			

Extraction Method: Principal Component Analysis.
Source: author's calculation in IBM SPSS Statistics 21.0 software.

Figure 1 shows the Scree plot. On the horizontal axis, there are numbers of separated factors, and on the vertical axis, there are corresponding characteristic value. After the fourth factor, there is a gradual decline in characteristic values, so in the further analysis four factors may be considered.

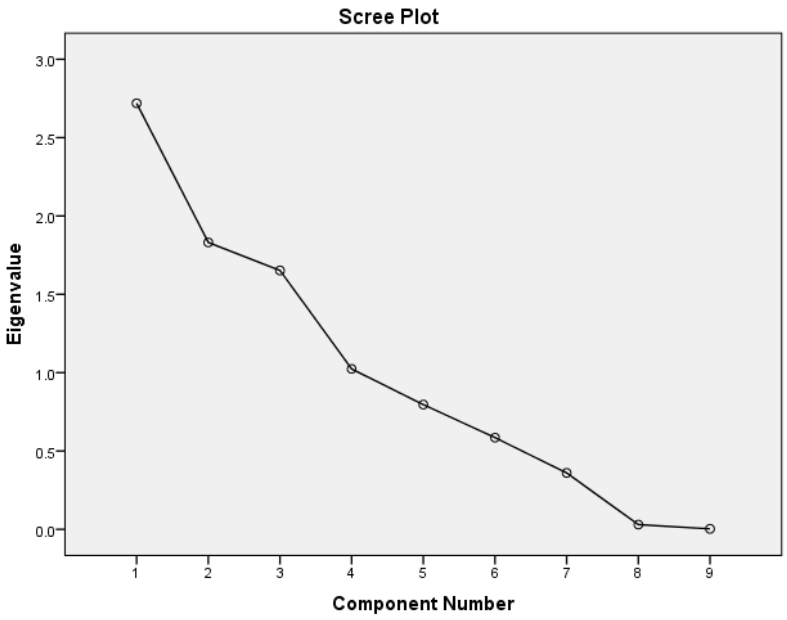

Figure 1 Scree plot

Finally, eigenvalues of rotated factors may be considered. Factor Analysis generates multiple solutions for the same data set. Each solution is one rotation. It is also important to mention that rotation retains the cumulative percentage of variations explained by selected factors, but the variability is allocated to the selected components or factors. Major changes in coefficients indicate that factors are easier to interpret. In general, rotation changes loads and the rotation table should give a clearer interpretation. Therefore, it is listed below (Table 3).

Table 3 Selected components

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
Import	.957			
Export	.940			
Electricity prices	.686	.206		-.167
Public debt	.111	.981		
GDP	.106	.981		
GDP per capita	.215		.822	
Deficit/surplus	-.215	-.195	.754	
HICP				.908
Unemployment rate		-.362	-.505	-.553

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization[a]
a. Rotation converged in 5 iterations.
Source: Author's calculation in IBM SPSS Statistics 21.0 software

In order to give the names to the factors or choose the original variables most meritorious to enter our model (which has been done, because sometimes the researcher may apply "surrogate" variable instead of factor scoring, i.e. linear combinations, which means that each factor choose one original change that has the highest factor weight with that factor and in some way represents it (Soldić-Aleksić, Krasavac, 2009), the previous table is very important. It is obvious that after factor rotation such a factor matrix is obtained where for each factor high values of factor weight can be distinguished, associated with a certain number of variables. Table 3 shows that the first factor is most correlated with the original "Import" variable, the second with the "Public debt" and "GDP" variables, the third factor is most correlated with the original variable "GDP per capita", the fourth factor is correlated with the original variable "HICP". So, these variables as indicators for ranking countries according to their level of development may be used.

Classification of countries by the level of development

List of countries based on calculated values of I-distance and Factor analysis

The commitment to the I-distance model is encouraged by the fact that this model satisfies all conditions that are inherent in the nature of intervals or multi-dimensional development and which gives the possibility of further consideration by using normed I-distance, square I-distance and I-distance with grouped indicators. A global index, which would indicate the level of development of a country in one absolute way, cannot be constructed. But, what can be determined is the relative position of a country in relation to other countries in the observed assemblage. That is how the notion of "distance" between the two countries in relation to their economic development is created. Table 4 contains data with a list of countries from the observed assemblage, based on the calculated values of the synthetic

development indicator, i.e. the values of linear I-distance, with and without application of Factor Analysis.

Table 4 The list of countries by the level of development

Country	I-distance	I-distance and Factor Analysis
EU-28	1	33
Germany	2	1
France	3	3
Italy	4	5
United Kingdom	5	2
Netherlands	6	4
Spain	7	7
Belgium	8	6
Poland	9	8
Austria	10	9
Switzerland	11	14
Sweden	12	11
Ireland	13	13
Czech Republic	14	10
Portugal	15	20
Greece	16	23
Denmark	17	16
Hungary	18	15
Island	19	22
Norway	20	12
Turkey	21	19
Finland	22	21
Slovakia	23	17
Romania	24	18
Slovenia	25	24
Bulgaria	26	25
Lithuania	27	26
Croatia	28	28
Luxemburg	29	27
Latvia	30	30
Estonia	31	29
Cyprus	32	31
Malta	33	32

Source: author.

Comparative analysis

As we can see, differences in rankings between some countries are small and some are distinct. In addition, several countries have not changed their rank. If we disregard the rank of EU-28, Table 5 gives the following final ranking of countries by the level of development:

Table 5 The final rank list by the level of development

Country	Final rank
Germany	1
France	2
Italy	3
United Kingdom	4
Netherlands	5
Spain	6
Belgium	7
Poland	8
Austria	9
Sweden	10

Source: author.

Significant alterations occurred in the following countries: Greece (rank 16-23), Hungary (rank 18-25), Slovakia (rank 23 to 17), and Romania (rank 24-18). Most countries had minor changes, while in some countries (France, Spain, Ireland, Croatia, and Latvia) there was no change at all.

Conclusions

The level of countries development is a multidimensional problem, which is necessary to enlighten its multiple sides with the choice of suitable macroeconomic indicators. When choosing a development indicator, it is necessary to start with a wider list of possible indicators, which will then be subjected to the significance analysis in order to bring the initial list of indicators to an "optimal" measure. This analysis is, de facto, an analysis of the significance of the observed economies, i.e. a complex quantitative analysis of the total economic potential of the observed countries.

The analysis has shown that the method of I-distance combined with factor analysis models leaves no possibility of subjective influence on the formation of the rank list, assuming that a set of indicators is known and that it has all the characteristics corresponding to the nature of the problem. Obtained rank list has shown that application of I-distance with and without "predecessor" method (in our case of factor analysis) gives the same rank list of countries according to the level of development. This is an excellent choice for economic policy makers (Governments) to focus their activities on the analysis of selected macroeconomic indicators. Likewise, I-distance is a method that (combined with factor analysis) gives the best rank based on the given indicators.

However, none of the models provides a solution that has an essential, cardinal meaning, that could lead us to conclusion what the real difference between observed countries based on its application be. The application of these methods is therefore limited on creating of ranking lists of the level of countries development, which can guide us in their development level analysis. It is impossible to create unique and permanent classification of countries because macroeconomics possesses many indicators that in different countries and in different periods have different values and mutual influences. Each country is also exposed to some other influences, such as culture, tradition, habits, number and population structure, where two numerically equal macroeconomic indicators in two countries may have different meanings.

One of many approaches to research has been used in this study, therefore the analysis can be extended, and further researches can be performed using other methods and approaches.

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