

Application of Method of Effective Ranking in the Construction of the Ratings (For Example, GDP per Capita)

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Abstract: The availability of and demand for the countries ratings that based on the key indicators of their socio-economic development has made the major international organizations publish such data and the rankings of the UN, The World Bank, the IMF are the most detailed and reliable in the world. However, the disparities and differences in the level of development of the countries is at such extent that the common distribution of the ranked values on the decreasing or increasing curve is not enough as this ordinal distribution does not take into account the non-linearity which is characteristic for the countries that achieved success in their socio-economic development. The development of an effective ranking method that helps to measure the non-linear distribution of the socio-economic development indicators and to take into account the degree of difference between the territories that are being ranked, allows any person concerned to assess the objects of management and get reliable information for the retrospect development of the territories as well as for an adequate definition of the targets of the strategic development, taking into account the current degree of differentiation for every socio-economic indicator or all together in the rating system. And this method can help not only to increase the reliability of the monitoring which concerns the results countries development but also is a tool to choose the priorities in investment, migration, development of external economic relations.

Key words: Effective ranking, degree of differentiation, ranking, monitoring of development, information, strategic, management

INTRODUCTION

The popularity and deep confidence in the ratings that characterize the result of development of the territory, industry, enterprise or that measure the result of achieving certain goals and targets reached at the end of the strategic management and socio-economic development. All this has allowed the authors to examine the methodology of ranking process and to represent their vision of a universal approach to the calculation and determination of the rankings of countries or regions that are made based on the traditional statistical indicators of socio-economic, environmental and human development of a territory.

The base of any rating calculations consists of the rank distributions of all the ranked objects that are summed up and give an integrated model about each participant place. The equalization of the levels of socio-economic development of different countries and

regions (and these levels are defined in the documents of the strategic planning and comprise the base for the government economic policies) should pursue an aim, above all for the socio-economic indicators which measure the different aspects of this development to become quantitatively more and more equal.

This means that the rank distribution of these indicators on the territories should become more and more right, tending-at the limit-to the horizontal line which indicates the full equality of values of the analyzed indicator for all the regions. The more effective and efficient the politics of equalization towards any of the aspects of the socio-economic development of the regions is the more equal the rank distribution of the indicator will be.

Rank analysis; Contents and spheres of application: The main idea of the rank analysis consists in the possibility to create with the help of relatively simple tools the

well-organized comparative assessment of the countries and regions. Most specific approaches create the homogeneous data from the territorial indicators, then they are being standardized in order to provide correctness of the interregional comparison and thus, the further comparisons are provided based on these calculations. They are made on a continuous or integer scale. The latter is called the rank comparison: when the territories (all that are being compared) are given the corresponding places according to the ordered values of the indicators. The examples of works that describe the classic rankings (Lagoutkin, 2008; Bhedash and Gourina, 2014; Hettmansperger, 1987).

The rank analysis offers an ordered occupancy of the objects according to the intensity of some criterion in this case the objects under investigation (e.g., regions) are arranged in the descending order of the investigated indicator value of this or that criterion.

Rank an order number of an object in a certain distribution. Under the Ranking Distribution (RD), we understand the distribution that results from the ranking procedure of the indicators values sequence (Sharkevich and Buletov, 2016).

The level of socio-economic development of the territory can be assessed with the help of many different indicators. This concept lacks the strict and concise definition among the experts as well as in various official documents at different levels of state management that is why there is no clear system of indicators while these indicators are taken by a subject of regional politics as a base for evaluation of their politics efficiency and effectiveness. In this situation, we may suppose that the indicators, the ranking distributions of which are the most equal are the true aim of equalization as it is actually represented by the subjects and objects of the regional politics.

The most equally distributed indicators of the territories are the description of the actual aims of the equalization politics these indicators represent the thing for which the regional managers are responsible and for which they report to the Federal authorities (Khrustalev, 2014).

The RD is the empirical law that corresponds to the nature of the socio-economic subject under investigation. To explain the regional distributions on the values of the investigated indicators a series of patterns are used that are based on various prerequisites. These patterns reflect of their researcher's hypothetical ideas about the formation process of indicator values structure, i.e., about the reasons of their quantity indicators proportion. RD can be used as a convenient "tool" for the comparative analysis of the Russian Federation regions socio-economic state.

Besides this prerequisite it is also necessary to take into account that when the Federal authorities determine

some indicator for which the management of a state, a region, a municipality bears responsibility, this may generate an affect of "work-to-achieve-indicator" when the management strives for providing the determined indicator value rather than obtaining the results per se and employs all the possible forms of opportunistic behavior. In other words in practice the indicators system that is used by the Federal authorities makes the regional and local authorities correct their aims and they have to shift from the efficient solutions to those "that correspond to the demands of the center".

MATERIALS AND METHODS

Method of effective ranking: Most of the empirical studies that describe the distribution of objects based on this or that indicator, deal with the analysis of the frequency form of distribution. However, alongside with the frequency distribution "criterion (indicator) frequency" it is possible to examine the ranking distribution "rank-criterion (indicator)" which gives additional information about the process of formation and distribution and about the impact of the "external" management on the distribution.

For example, there are many regions, each of them is characterized by a specific value of a criterion (x) and by a Rank (R) in the series of regions that are ranked according to this criterion where the rank 1 is assigned to the region with the highest value of this criterion. Then the function $x = f(R)$ is called a ranking distribution of the regions by the value of criterion x .

Let us represent the results of the world economy development by the achieved level of economic development using the indicator of GDP per capita, the data are taken from the official documents of the IMF for 2013-2015 (IMF., 2016). Now, we explain the content of the effective method of ranking as well as the researcher's interpretations of its application.

It is believed that GDP per capita if we talk about the purchasing power parity is the most accurate indicator that describes the level of economic development and economic growth (Khrustalev and Slavyanov, 2016). All figures for comparison are indicated in a single currency US dollar. We should also remember that different countries use different systems of national accounts. So, the United States, Canada, Russia and 28 EU countries reported their data for 2014 in accordance with a new 2008 SNA, other countries in the 1993 SNA. The main difference of 2008 SNA is that it additionally takes into account the intellectual property, derivative financial instruments and spending for R&D and armaments expenditures. Thus, adding the new accounting items leads to a significant increase in the macroeconomic indicators.

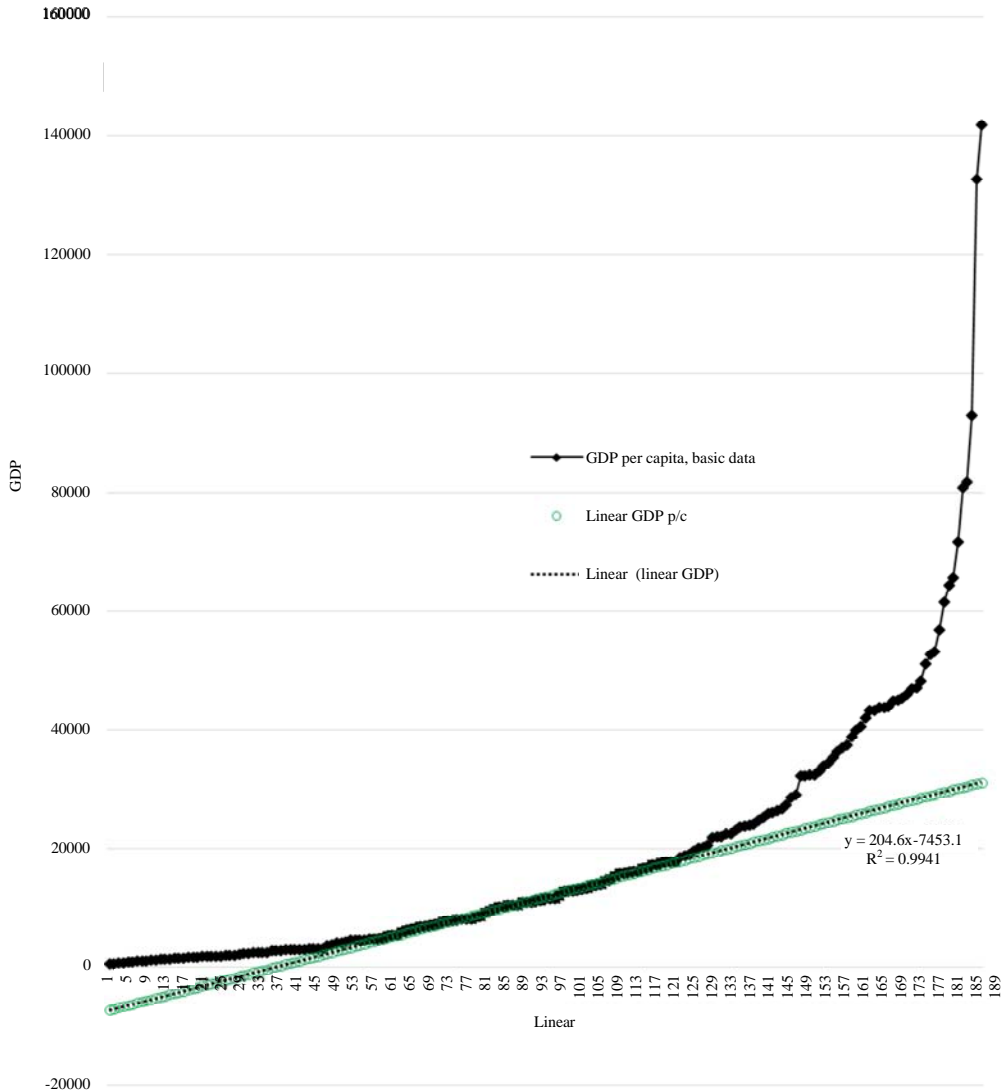


Fig. 1: The empirical ranking distribution of GDP per capita (◆), a linear rank distribution pattern (■) and a GDP per capita linear approximation (-●-)

Figure 1 (except for the initial data on GDP per capita by country in 2013) shows the characteristics of the linear trend built on the most uniformly varying values of GDP per capita for countries from Moldova (order number 58) and to Mauritius (order number 123). By this trend the equation of the linear subsection is represented with the parameters and the value of the coefficient of determination $R^2 = 0.9941$. Similarly, the values of GDP per capita and their additional parameters were made for 2014 and 2015.

The Ranking Distribution (RD) can be represented as with the GDP per capita (GDP p/c) increase the region rank also improves. Then, the data will be presented in the standard format the highest value of GDP p/c will have the rank equal to 1.

The Empirical Ranking Distribution (ERD) of GDP p/c is shown in Fig. 1 with a marker (◆). As seen from Fig. 1, the rank 1 corresponds to the minimum value of GDP p/c, and rank 189 to the maximum value. The range of GDP p/c in US dollars:

$$R = \text{GDP p/c}_{\max} - \text{GDP p/c}_{\min} = 141851 - 605 = 141851$$

For further detailed description of the method a Linear Ranking Distribution (LRD) was created:

$$\text{LRD} = 605 + (i-1) \cdot h \tag{1}$$

Where:

- $i = 1, \dots, 189$ rank r of a country
- $h = R/188 = 141851/188 = 751.31$

ERD of GDP p/c is non-linear compared to LRD (Fig. 1). The values of GDP p/c for ERD and LRD differ significantly but have the same ranks. This means that the ranks of the countries are non-sensitive to changes in the form of the monotone ERD in the range from 1-189. This is due to the fact that the usual RD does not reflect the non-linear nature of the ranked indicator as the rank r is the usual number of values for this RD.

That is why the researchers have set a task to create an ERD that could reflect the structure of value part GDP p/c. The more the values of GDP p/c would differ, the more their corresponding ranks would differ from each other. In other words to display the non-linear structure of GDP p/c values in the corresponding structure of positive integers, i.e., to build an isomorphic mapping as follows:

$$y = kr + \alpha_0 \tag{2}$$

Where:

- y = Indicator of GDP p/c
- k = Linear coefficient
- r = Rank of a region
- α_0 = Absolute term

A pattern LRD (dark marker ■, Fig. 1) does not reflect the structure of value part of the countries GDP p/c as the ranks r of the RD are in fact the numbers of these GDP p/c values. Therefore, from the set of the linear mappings type it is necessary to define such a mapping that could at least partially coincide with the values of ERD and thus could take into account the peculiarities of this RD, i.e., we should find an approximately linear part in ERD and use it to find the parameters for the linear mapping.

As practice shows, a set of RD built for different indicators have a linear part of the ranked indicator

dependence from r . There is a part in the rank range from 58-123 (Fig. 1) for the ERD of GDP p/c. This part with a high degree of reliability ($R^2 = 0.9941$, MS Excel) is approximated by a linear mapping as follows (Fig. 1) $y = 204.26x - 7453.1$:

$$y = 204.26 \cdot r - 7453.1 \tag{3}$$

A linear coefficient $k = 204.26$ reflects the degree of homogeneity, differentiation and leveling of the countries against the GDP p/c value. The bigger k is the more the differences among the countries for this value are.

Substituting in the Eq. 2 the empirical values of GDP p/c for the countries for 2013 and solving it relatively to rank r , we can write the following definition for it:

$$R = \text{Integer}[(y - \alpha_0) / k] \tag{4}$$

Where:

- y = Empirical GDP p/c values for the countries in 2013
- $\alpha_0 = -7453.1$
- $k = 204.26$

Integer (argument) function that rounds down its argument to the nearest lower integer. Isomorphic Eq. 2 of the empirical values of GDP p/c with regard to the Eq. 3 and the additive parameter change α_0 shown in Fig. 1. Thus, the desired linear isomorphic Eq. 2 is as follows:

$$y = 204.26 \cdot r^* - 7453.1 \tag{5}$$

where, r^* effective ranking (its definition please find below). Figure 2 shows that to reflect the structure of the parameter set of GDP p/c for 2015, a range of ranks from 1-692 is required.

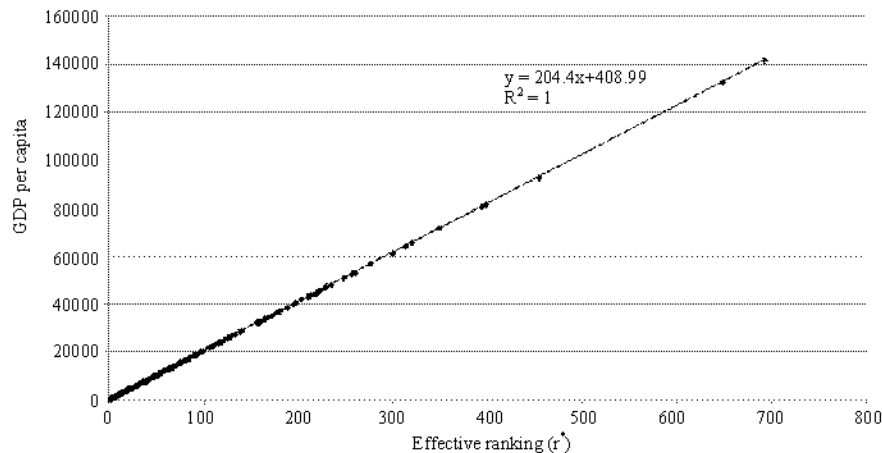


Fig. 2: Linear isomorphic mapping $y = 204.26x - 7453.1$ of the structure of the GDP p/c range in the set of positive integers the effective rank r^*

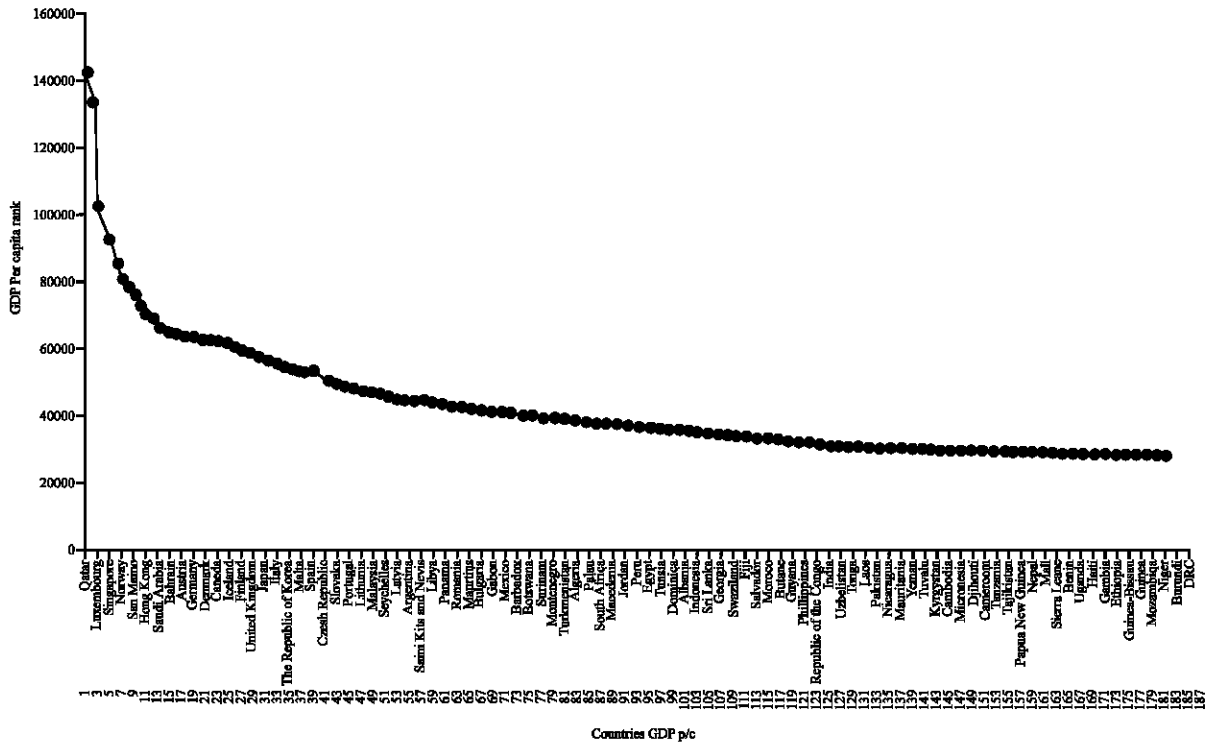


Fig. 3: Ranking distribution of r and r^* of the countries GDP p/c in 2013

Resaerchers interpretations: In the proposed method a new ranking r which enters into the Eq. 2-5, may be called an effective ranking for the following reasons. Firstly, it reflects the effect of non-uniformity of distribution of GDP p/c on the interval (605; 141851).

Secondly, its value differs from the order number (rank) r of the ordered values of the country's GDP p/c. Thirdly, in order to implement all values of the ranking r^* , it was necessary to have 692 countries that could have 692 values of GDP p/c that are uniformly distributed on the interval (605; 141851).

In this research, we propose to call the linear coefficient k which enters into the Eq. 2-5, the coefficient of the inter-regional differentiation equalization (the smaller the k is the smaller the variation in the value of the ranked GDP p/c is).

After the simple additive changes the effective ranking distribution of GDP p/c by countries in 2013 may be presented in the traditional form when the effective rank $r^* = 1$ corresponds to the highest value of GDP p/c (Fig. 3).

The efficient distribution of ranking of GDP p/c = $f(r^*)$ is more sensitive to the changes in the ranked indicator than its traditional ranking by r (in fact, it is the numeration).

Analysis of Fig. 2 and 3 shows that such a situation may happen when the rank r of a region will not change

but in the effective ranking distribution $IA = f(r^*)$ the significant changes may occur. For example, r^* may significantly change. This behavior r^* is important in terms of monitoring the effectiveness of regional and Federal authorities measures to improve the socio-economic situation on the sub-national and country levels.

Effective ranking of countries by GDP per capita: The researchers have made the similar calculations for the effective ranking for 2014-2015 and obtained the following results.

We took for the comparative analysis ten leading countries by GDP and defined their place in the traditional ranking of GDP p/c (Table 1). Then, we grouped the change of the effective ranking by GDP p/c of these countries for 2013-2015. As a result, we may claim that PRC (China), that has the largest GDP in the world the order number 1 by GDP is ranked just 84 by GDP p/c for PPP and the dynamics of the effective rank gives it the position from 636 out of 692 items in 2013 to 573 out of 639 items in 2015. The gap between the ordinal rank of 84 and the efficient indicators in 2013-2015 shows that the extent of the lagging from the leader Qatar which traditionally takes 1st place in the ordinal as well as in the efficient ranking is significantly more than 84 ranks. Another interesting result the degree of difference effective

Table 1: Comparison of the results of the traditional and effective ranking of the leading countries for GDP and GDP per capita

Ordinal rank				Effective ranking by GDP p/c		
By GDP	By GDP p/c	No./No.	Countries	2013	2014	2015
2	10	1	USA	437	393	371
5	18	2	Germany	475	432	414
10	24	3	France	499	458	442
9	25	4	The United Kingdom	505	461	442
4	27	5	Japan	515	474	457
6	48	6	Russia	568	528	518
7	76	7	Brazil	616	575	566
1	84	8	PRC	636	589	573
8	99	9	Indonesia	646	601	588
3	122	10	India	669	624	612
Maximum Quantity of ranks				692	649	639

Table 2: Effective ranking of the leading countries by GDP p/c for 2013-2015

Leading countries by GDP p/c	2013	2014	2015
Qatar	1	1	1
Luxembourg	240	195	161
Macao (PRC)	45	45	166
Singapore	299	254	228
Brunei	295	272	256
Kuwait	345	316	301
Norway	374	332	310
The United Arab Emirates	380	337	314
San Marino	394	358	335
Switzerland	417	375	358
Maximum quantity of ranks	692	649	639

ranks of developed and developing countries is not as significant (if r^* of the United States in 2015 was equal to 371, India had 612 that is 1.65 times higher than the US rank, whilst the ordinal ranks of these countries differ for 12.2 times). Nevertheless in the effective ranking they are arranged successively the economically developed countries appear first on list, the second part of the list starting with Russia includes the economically developing countries.

If we analyze the dynamics of the effective ranking of the leading countries for GDP p/c for 2013-2015 (Table 2), we may see that the composition of the countries did not change as well as the sequence of their listing by GDP p/c. At the same time the degree of differences of the countries with the ordinal numbers 2-10 from the leader Qatar, differs much more significantly than than traditional ordinal numbers, that allows to talk about the non-linearity of the distribution of countries (Fig. 1) and about the reliable measurement of differentiation of the countries against the indicator selected for ranking.

Reduction of the maximum quantity of the effective ranks from 692 in 2013 to 639 in 2015 indicates the strengthening of “compression” of countries with minimum and maximum values of GDP p/c (non-linear “tails”), at the same time there is no significant change in the slope of the curve, only its length changes depending on changes in the value of the maximum r^* (Fig. 4).

Effective ranking scope of application: Application of the described method of effective ranking is of current

importance both to improve the reliability of comparative analysis or monitoring of countries, regions with each other by the achieved level of development as well as to make the adequate and relevant government decisions on development priorities and problem spheres of socio-economic and environmental development that carry a threat for the general national security.

The selection of a list of socio-economic indicators by which a ranking should be made, remains an open-ended question. The possibility of the automated calculation of the ranks allows to include a full set of the development indicators from the national and international statistics into the ranking. Ranking is determined by a simple summation of all the calculated ranks. As a result, we have a complete idea about the current state as a result of the development and implementation of all public administration strategic measures:

$$\text{Rating}_{\text{of countries}} = \sum \text{Ranks}_{\text{indicators of socio economics development}} \tag{6}$$

A government need for an effective and ancient tool for monitoring and for a method of determining the results of the development of regional and national socio-economic systems in order to improve the effectiveness of the entire management and control system may be met by using the traditional methods of statistical analysis, that received the new researchers vision and interpretation.

The ranking distributions that take into account the non-linearity of the socio-economic indicators distribution, allow not only to improve the methodology for the study of regional and national socio-economic systems but also to raise the level of interpretations and concerned with them management decisions on the regional or national economic policy.

In the structural economic policy which is developed by a government, it is necessary to include the improvement of the country ranking distribution on the global economy rating by its socio-economic development indicators. This will help to obtain a realistic

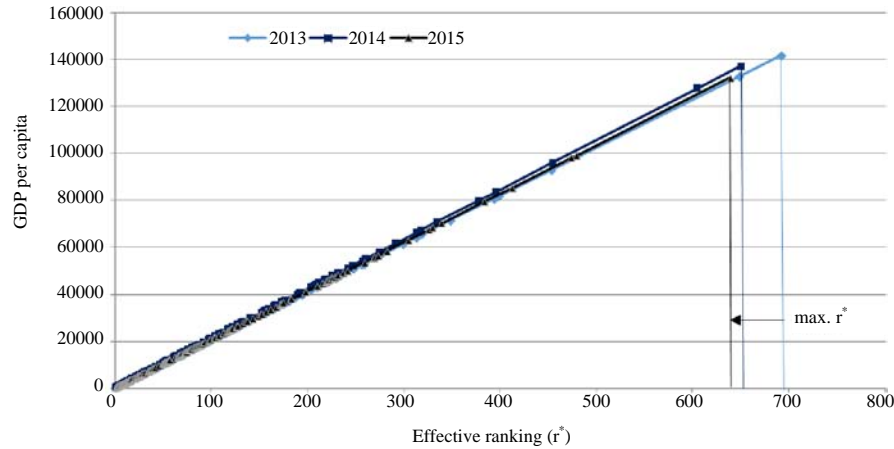


Fig. 4: Change of the curve of a linear distribution of countries by GDP p/c using an effective ranking

understanding about the level achieved at a certain period of time, taking into account the difference among the countries because of the significant disparity of development and pronounced non-linear distribution of the basic values of the socio-economic indicators. And then a government may have a practical indicator to assess the effectiveness of public administration and to determine the level of development potential that a country had and whether it was (or was not) successfully implemented (Zlochevsky and Buletova, 2015).

CONCLUSION

The application of the effective ranking method by GDP per capita and other indicators that describe the results of their socio-economic development for the ranking and rating of the IMF, the World Bank, the United Nations is an efficient way to improve the accuracy and relevance of this method and its results that are used to describe the state of the world economy and the place and role of each country.

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