

Structural Differences of Economies of Different Developmental Types: Assessments and Effective Ranking on a Global Basis

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Abstract

Monitoring, analysis of the economic development results achieved by developed and developing countries requires new more accurate and correct approaches and interpretations. This paper presents the authors' research conclusions on the use of patented in Russia original approaches to the structural analysis of the world economies and their rating which are of practical interest for expert assessments and typologization of the world countries (or regions of one country) in dynamics and comparison.

Keywords: coordination, industrialization, service economy, structural analysis, effective rank, nonlinear distribution.

INTRODUCTION

Basing on obtained the results in the article "Structural analysis and criteria for assessing the state of economic policy" [1], the authors set a new research goal which is not just to compare the results of structural changes in economically developed countries (such as Germany and Japan) and emerging economies as China and Russia), but also to supplement the results of structural analysis by applying a patented approach to the data obtained when rating the target research countries [2].

INTERPRETATION OF RESULTS OF STRUCTURAL ANALYSIS OF DEVELOPPED AND EMERGING ECONOMIES

Following the three-sector model of economy (suggested by Clark-Fisher) and the economy sectoral division of gross added value, we will use:

1) The system of indicators reflecting the share of the main sectors in the total amount of national gross added value (GAV) (Table 1)

2) The system of indicators coordination reflecting the interrelation result of the D_i indicators:

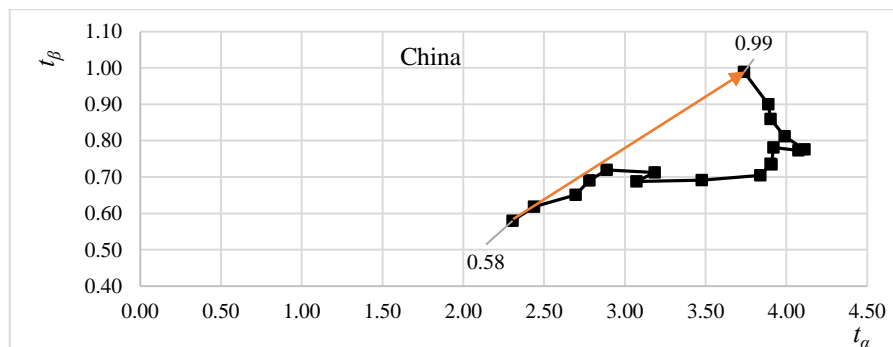
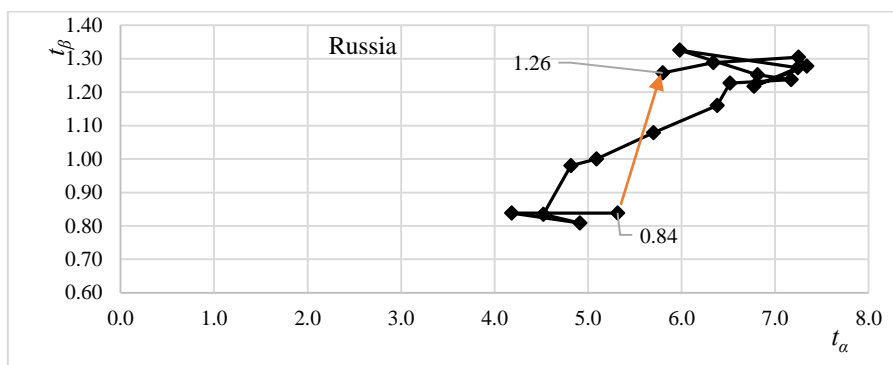
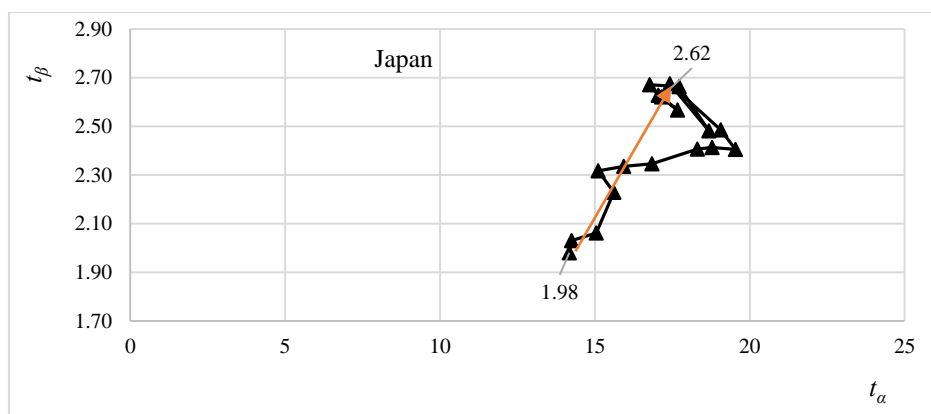
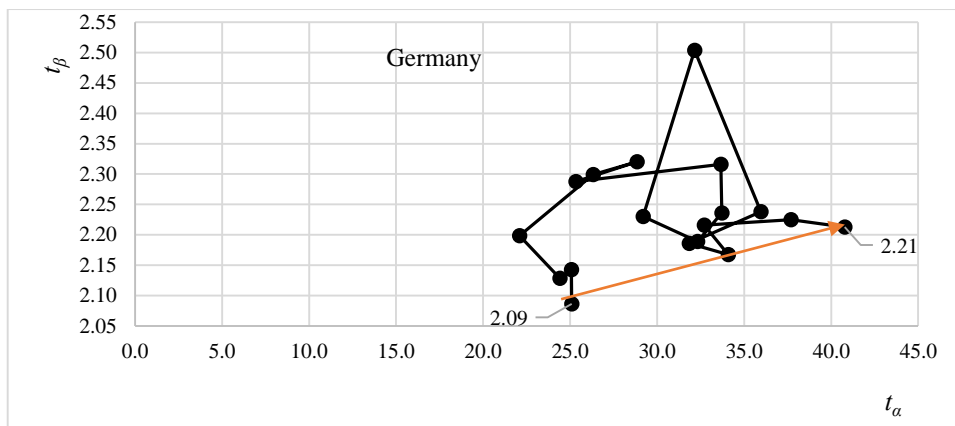
$$t_\alpha = D_I/D_A \quad t_\beta = D_U/D_T$$

In the course of the research it was determined that the greater the values of t_α and t_β exceed the value of 1, the more developed the economy is in its structural changes over the period. Accordingly, such economy is referred to as an economy with developed industrial and service sectors.

Using the data on the GAV structure of the world economies and the Russian Statistics Agency (Rosstat) data, D_i calculations were carried out for four countries including Germany, Japan, China and Russia, with the subsequent calculation of the values of t_α and t_β , t_β presented in Fig. 1.

Table 1: Distribution of OKVED (Russian Standard Industrial Classification of Economic Activities sections) sectors by relative share D_i for structural analysis

No/№	Kind of Economic Activity at current prices in Gross Value Added	D_i Characteristics	
1	Agriculture, hunting, forestry, fishing (ISIC A-B)	D_A - relative share of the Agrarian Sector, %	D_T - relative share of the Goods Production Sector, %
2	Mining, Manufacturing, Utilities (ISIC C-E)	D_I - relative share of the industrial sector, %	
3	Construction (ISIC F)		
4	Wholesale, retail trade, restaurants and hotels (ISIC G-H)		
5	Transport, storage and communication (ISIC I)	D_U - relative share of the Service Sector, %	
6	Other Activities (ISIC J-P)		
	Total Value Added	100%	



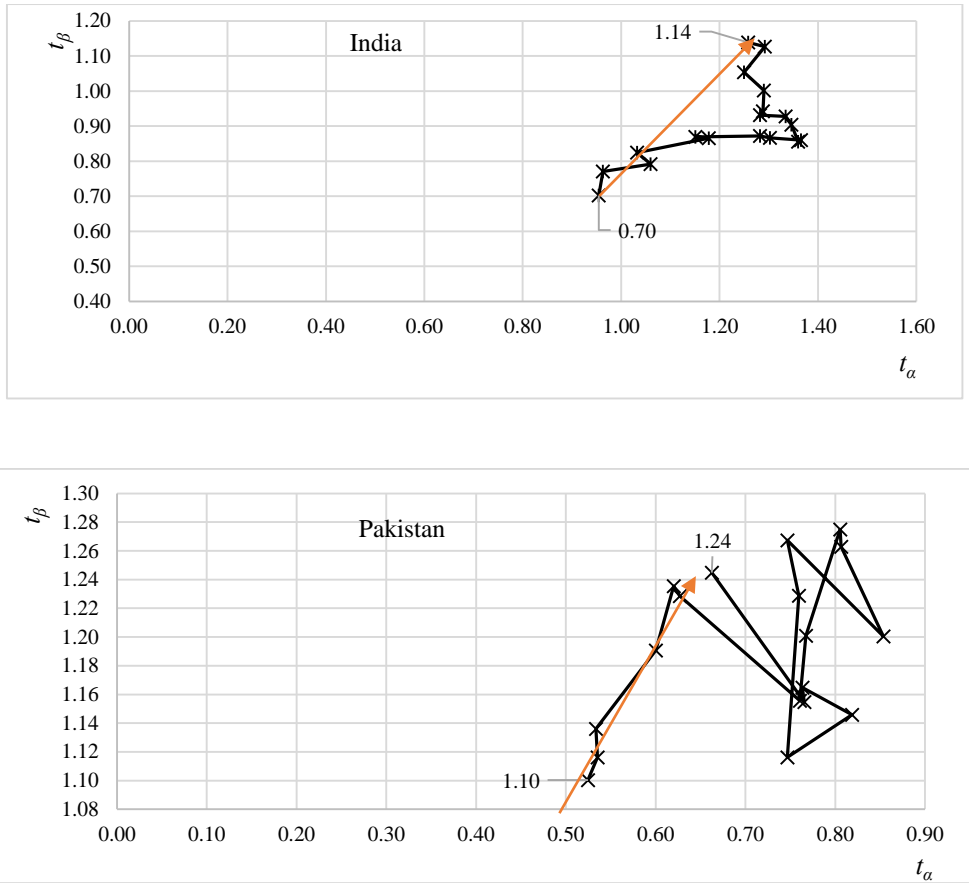


Figure 1: The result of t_α and t_β ratio in the analyzed group of countries in 1998-2015.

Source: compiled by the authors using materials of the United Nations "Gross value added (GVA) by economic activity at current basic prices" and Rosstat "Branch structure of the gross added value of the subjects of the Russian Federation"

Fig. 1 shows the correlation of t_α and t_β and reveals that if the vector of structural changes in all analyzed countries is similarly increasing the values of t_α and t_β that indicates an intensification of industrialization and service economy for the analyzed period, the magnitude of such changes is different and the results economic development indicators are diverse too:

- the example of Germany and Japan as typical countries with developed economies on the European and Asian continents

shows that the tendency to increase the level of industrialization (t_α), when the share of industrial production is ten times greater than the that of agriculture, against the background of an insignificant excess of services sector over the production in the range of 2-3 times (t_β). This indicates a higher stage of economic development than other variants of the relations, hence the simple condition that $t_\alpha > 1$ and $t_\beta > 1$ is insufficient for a complete and correct countries ratio. An additional internal scale is required as presented on Fig. 2, but it is necessary to take into account the mixed type variant as a transitional state of the national economy (the example of Pakistan), when against the background of a "disastrous" value of one t (for example $t_\alpha < 1$), the value of the other t will be optimal (for example, $t_\beta > 1$)

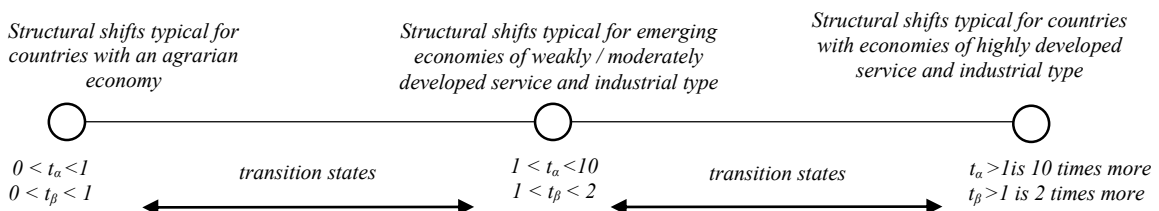


Figure 2: An example of scaling and interpreting the values of t_α and t_β in the proposed typology

Table 2 shows the systematization results of the authors' conclusions and interpretations to better understand the structural change features in each of the studied countries.

Table 1: Interpretation of the results of the structural analysis of Germany, Japan, China and Russia in 1998-2015.

Country	1998	2015	Characteristics of the results of economic development and structural changes
Germany	$t_\alpha > 1$ is 25,1 times more $t_\beta > 1$ is 2,09 times more	$t_\alpha > 1$ is 40,8 times more $t_\beta > 1$ is 2,21 times more	Service-industrial type with a high level of development of industry and services. Against the background of a decline in the share of agriculture t_α grew almost 2-times with a stable ratio of services and material production (t_β)
Japan	$t_\alpha > 1$ is 14,17 times more $t_\beta > 1$ is 1,98 times more	$t_\alpha > 1$ is 17,16 times more $t_\beta > 1$ is 2,62 more	Service-industrial type with a steadily developing industrial sector and a high level of development of the service sector. The uniform consistent growth of t_α and t_β indicates a balanced structural economic policy of the state
China	$t_\alpha > 1$ is 2,3 times more $t_\beta < 1$ (0,58)	$t_\alpha > 1$ is 3,74 times more $t_\beta < 1$ (0,99)	Industrial type with an actively developing service sector. Regular decrease of the agricultural share in the structure of the GVA (almost 2-fold over the period) was accompanied by a decrease in the share of industrial production (by 14.4% over the period), as the service sector share increased (by 35.6% over the period)
Russia	$t_\alpha > 1$ is 5,3 times more $t_\beta < 1$ (0,84)	$t_\alpha > 1$ is 5,8 times more $t_\beta > 1$ is 1,26 times more	Transition from industrial to service-industrial type of economy with insignificant rates of development
India	$t_\alpha < 1$ (0,95) $t_\beta < 1$ (0,7)	$t_\alpha > 1$ is 1,26 times more $t_\beta > 1$ is 1,14 times more	The transition from an agrarian to a weakly developed service-industrial type of economy
Pakistan	$t_\alpha < 1$ (0,52) $t_\beta > 1$ is 1,1 times more	$t_\alpha < 1$ (0,66) $t_\beta > 1$ is 1,24 times more	Stable agrarian-service type of economy

The revealed regularity in ratio changing of the sectors of national economies of developed and developing countries determines not only the vector of their future development, but also confirms the relevance of the author's approach to structural analysis. The structural analysis is used for assessing the results of economic development and outcomes of implementation of public structural economy, for evaluation of the competitiveness level, national economies stability, the strength of reaction to the dynamics of prices in commodity market and, migration flows in the world labor market. The fact that there are countries that are actively transforming the structure of their national economy (the example of India, Russia and China) distinguishes them from countries that do not progress in the development of the

industrial sector, remaining adherents of traditional economic priorities (agriculture against the backdrop of a growing service sector that is the example of Pakistan).

Fig. 3 shows the comparison result of the identified structural changes of national economies studied in the paper. The obtained distribution on the coordinate axis allowed to carry out the sectoral division of the graph field with the author's interpretation of each sector. The importance of the blue line should be especially noted. It has a cyclic form, indicating such a sequence of evolutionary development of the economy. The characteristics of all the sectors listed in Fig. 3 are presented in Table 2.

Table 2.: Characteristics of economies types following on from the structural analysis results

Type name (sector)	Structural change conditions	Interpreting the type of economy
<i>Sector 0 is typical for the least economically developed countries</i>		
Zero sector	k_α and $k_\beta < 1$	<i>Agrarian type of economy, typical for the most economically under-developed countries and regions</i>
<i>Sector A is typical for countries with less-developed economies</i>		
Sector A1	$k_\alpha < 1$ $k_\beta > 1$	<i>Agrarian-service type of economy, typical for economically less-developed countries and regions</i>
Sector A2	$k_\alpha > 1$ $k_\beta < 1$	<i>Industrial type of economy, this type is more developed in comparison with the sector A1</i>
<i>Sector B is typical for countries with a steadily developing economy</i>		
Sector B1	$1 < k_\alpha < 20$ $1 < k_\beta < 2$	<i>Service type of economy which is characterized by priority development of the service sector in comparison with the production of goods</i>
Sector B2	$10 < k_\alpha < 20$	<i>Highly developed industrial type of economy, more developed than the sector B1</i>

	$1 < k_\beta < 2$	
<i>Sector C is typical for countries with highly developed economies</i>		
Sector C1	$1 < k_\alpha < 40$ $2 < k_\beta < 4$	Service-industrial type of economy is typical for economically developed countries with the development priority of services over material production
Sector C2	$20 < k_\alpha < 40$ $1 < k_\beta < 4$	Industrial-service type of economy, this type is more developed in comparison with the sector C1
<i>Sector D is typical for countries with the most intensive and sustainable economic development</i>		
Sector D1	$1 < k_\alpha < 60$ $4 < k_\beta < 6$	The most developed service-industrial type of economy, which determines the vector of the future development of economy structure
Sector D2	$40 < k_\alpha < 60$ $1 < k_\beta < 6$	The most developed industrial-service type of economy that follows the sector D1

Sector A occupies the area from the beginning of the coordinate axis to the separating the field red line going along the X axis and along the Y axis. This is the sector in which economically underdeveloped countries or countries with a traditional agrarian economy types are present (or used to present in the dynamics of the retrospective analysis).

Pakistan falls completely in this part of the sector (over the entire period of analysis). In India, we can see a deliberate movement towards the growth of the industrial sector over the agrarian one. At the same time in this country we observe a steadily growing sector of services which exceeds the production of goods and services sector. As a result, by 2015, India has "left" sector A, strengthening its economic position and moving to sector B1 (see below the explanation on this

sector).

China like India was in Sector A almost throughout the whole analysis period, but subject to the restriction that against the background of $t_\beta < 1$, the values of t_α were greater than 1, that is, the problems of the country's structural growth were concentrated on the development of the services sector at a greater rate than that of production of goods. For Russia, sector A in the first years of the analyzed period had similar characteristics to China against the background of a larger excess of the industrial sector over the agrarian sector. And since 2004 there has been a steady trend of increasing the value of t_β , which indicates the development of the service sector at a higher rate than that of goods production. Over the period of 2004-2015 Russia was located in Sector B1.

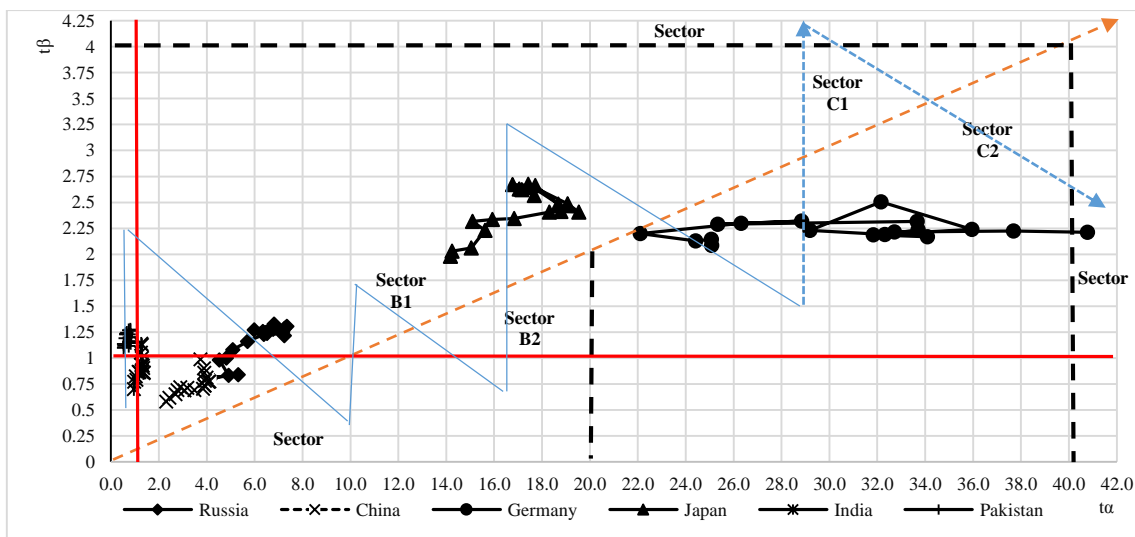


Figure 3: The result of t_α and t_β ratio of the economies of the analyzed countries in 1998-2015.

Passing from sector A to characterizing sectors B1 and B2, we represent them in comparison with each other:

for sector B1 (India, Russia and China at the beginning of the transition) the developmental priority is in the services sector in comparison with the production of goods while maintaining the growth of the industrial sector over the agrarian one. This distinguishes the structural policies and investment priorities of

the above listed countries;

- Sector B2 is characterized not only by high rates of the industrial sector growth of national economies, but also by the continued increase in the services sector over the goods production sector. In comparison with sector B1, this is a more economically developed direction of structural shifts which is the goal of economic policy witnessing its success.

We now turn to authors' interpretations of sectors C1 and C2 and compare the economies of Japan and Germany. Each of these countries has its own national characteristics of economic development, and each one has its advantages from being in these sectors, determining the features of the structural development. For the C1 sector, the priority growth of the services sector against the backdrop of stably developing industrial production sector is typical. Using the example of Japan with its limited natural resources, against the backdrop of a high level of industrial production technologies development and high availability of investment, including through a high level of external debt including public external debt, the national economy will ensure the priority of development of services over material production as more profitable, with a number of advantages over the goods production. These benefits include absence of transport and storage costs, no bulky production facilities occupying large territories and requiring maintenance, repairing, depreciation, no restrictions in consumption and simplified version of quality control. These factors were identified by the service consumers during a survey the most prioritized and popular ways to verify the quality of services).

In contrast to C1, for the C2 sector in which Germany was located over the entire analyzed period, it is typical to develop material production against the backdrop of growing automation of agriculture and the entire agro-industrial complex of the national economy. This factor is holding back the growth in the ratio of the services sector and the production sector. Nevertheless, the services sector is also developing and growing, but not as noticeably as in the C1 sector.

Further division of the graph into new sectors is already possible, as it can be seen from the example of Germany that in the course of the year 2015 the curve for this country was brought outside the C2 sector into the sector D. This indicates further economic development, widening the gap in the shares of different economy sectors, the increase in automation and growth in both goods production and accessibility and high demand for services.

DEVELOPMENT OF RANKING CONSIDERING THE INEQUALITY AND NON-LINEARITY

Rank distribution of all objects of ranking is the basis for any ranking calculation; the distributions are summed up and give a cumulative representation of the occupied place of each object. Practical implementation of the goal of leveling of countries or regions social and economic development is set as a goal in many strategic planning documents and form the foundation of public economic policy. It should be noted that social and economic indicators that measure the various characteristics and levels of this development, should be similar in their quantitative values. This means that the rank distribution of such indicators across the territories should

become more and more uniform, gravitating primarily to the horizontal line which corresponds to the situation of complete equality of the values of the analyzed indicator for all regions. The more effective the levelling policy is regarding to one of the aspects of socio-economic development of territories, the more uniform the rank distribution of the corresponding indicator turn out to be. Rank analysis involves an orderly placement of manifestation rate of a feature, while the studied objects (for example regions) are arranged in descending order of the value of the studied indicator of this feature.

The majority of empirical studies of object distributions based on some feature is connected with the analysis of the frequency distribution form. However, along with the frequency distribution where "feature (indicator) is frequency" it is possible to investigate the rank distribution where "feature (indicator) is rank" which gives additional information on the process of distribution and on the effect of "external" regulation factor on the distribution.

The analysis of the results of the world economy development is based on the achieved level of economic growth, we present it here using the example of GDP per capita, data retrieved from the official IMF report over the 2013-2015 period. [3]. The effective ranking method is patented in the Russian Federation, it was registered and authorized by state authorities on the state registration as a computer program "Calculation of the effective rank of objects by their features value". The database is based on GDP per capita at purchasing power parity, for better comparability of GDP per capita in all countries it is expressed in a single currency the US dollar Federal Reserve System. It should also be noted that countries use different systems of national accounts. So the US, Canada, Russia and 28 EU countries submitted their data for 2014 using the latest version of the international statistical standard for the national accounts the System of National Accounts 2008 (2008 SNA). Other countries used the previous 1993 SNA version. The main difference of the SNS-2008 version is that it additionally takes into account intellectual property, derivative financial instruments, R & D expenditures and armaments. Thus, the addition of new accounting articles leads to a significant increase in macroeconomic indicators.

On the basis of initial GDP per capita data for the countries of the world in 2013-2015, we presented the linear trend characteristic, constructed according to the most uniformly changing values of GDP per capita for the world countries (in the example of 2013, from Moldova (58 serial number) and to Mauritius (123 serial number), according to which the equation of linear dependence with parameters has the coefficient value Determination R^2 equal to 0.9941). Similarly, GDP per capita values and their additional characteristics for 2014 and 2015 were built. For further description of the method, a linear rank distribution (LRD) was modeled:

$$LRD = 605 + (i-1) \cdot h, (1)$$

characterized in that $i = 1, \dots, 189 - r$ country rank;
 $h = R/188 = 141851 / 188 = 751,31$.

The effective rank distribution (ERD) of GDP per capita is nonlinear compared to LRR [4]. Values of GDP per capita differ significantly in ERD and LRR rankings, but they have the same r ranks. This means that the ranks of countries are not sensitive to the change in the form of a monotone ERD in the range from 1 to 189. This is due to the fact that the conventional rank distribution does not reflect the nonlinear character of the ranked indicator, since rank r is the usual number of values for a given rank distribution. For ERD of GDP per capita there is a linear section in the range of rank from 58 to 123 (Moldova-Mauritius). This section with a high degree of reliability ($R^2 = 0,9941$ MS Excel) is approximated by a linear mapping of the form: $y = 204.26x - 7453.1$

$$y = 204,26 \cdot r - 7453,1 \quad (2)$$

The linear coefficient $k = 204.26$ characterizes the degree of homogeneity, differentiation or equalization of the countries of the world in terms of GDP per capita. The higher k is, the greater the intercountry differences in this indicator are. Fig. 4

shows that a range of ranks from 1 to 692 is required to display the structure of the set of GDP per capita values that were observed in the world countries in 2013.

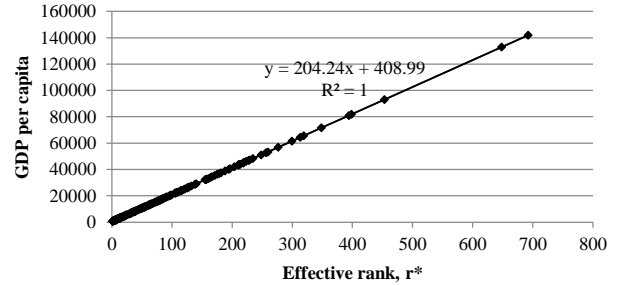


Figure 4: Linear isomorphic map $y = 204.26x - 7453.1$ structures of the set of values of GDP per capita in the set of centurms is the effective rank r

After simple additive transformations, the effective rank distribution of GDP per capita by the world countries in 2013 can be represented in the traditional form, when the effective rank $r^* = 1$ corresponds to the highest value of GDP per capita. (see Fig. 5).

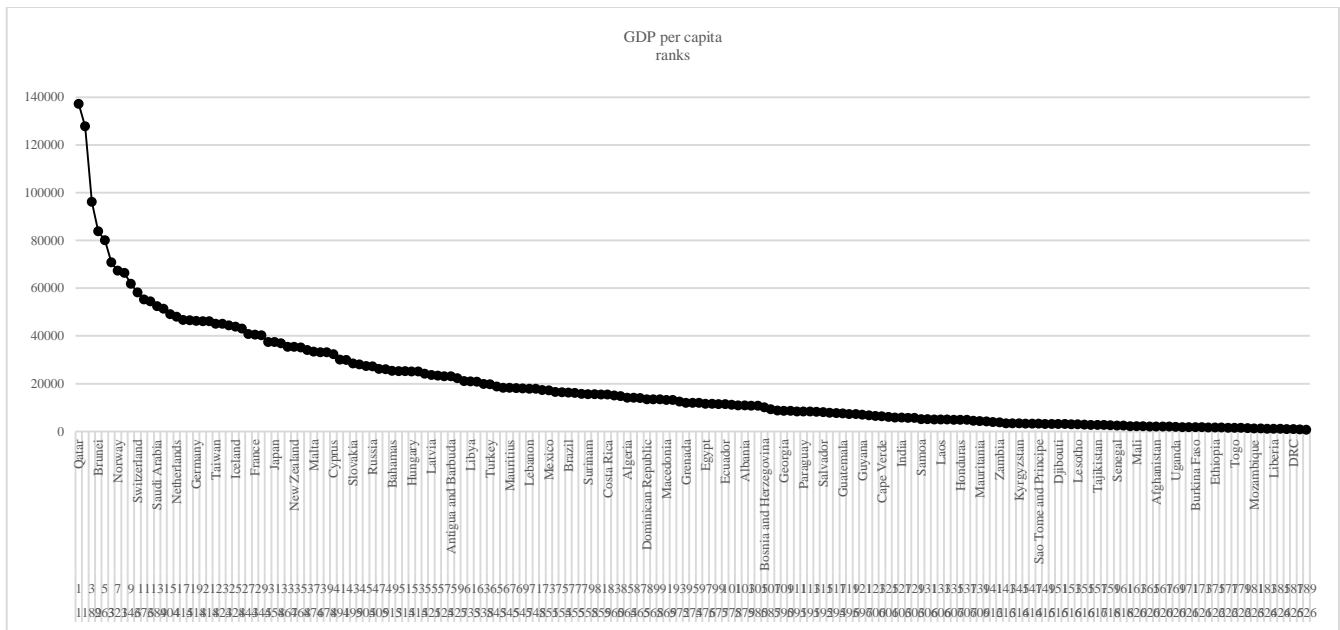


Figure 5: Rank distribution of r and r^* of GDP per capita of the world countries in 2013y

Effective rank distribution of $GDP\ per\ capita = f(r^*)$ is more sensitive to changes in the ranked indicator than its traditional ranking by r (which is actually a simple numbering). The analysis of Fig. 4 and 5 shows that a situation can occur where the rank r of the region does not change, and significant changes can occur in the effective rank distribution. For example r^* can change significantly. This behavior of r^* is

important from the point of view of monitoring the effectiveness of the actions of regional and federal authorities to improve the social and economic situation at the subnational and country levels.

EFFECTIVE RATING OF THE WORLD COUNTRIES BASED ON GDP PER CAPITA

Having carried out similar calculations of the effective ranking according to 2014-2015 data, the authors have obtained the following results:

First we took ten countries world leaders in GDP for comparative analysis and determined their position in the traditional ranking by GDP per capita (Table 3), and then we presented in a grouped form the change in the effective rank for GDP per capita in these countries in 2013-2015. As a result, it can be argued that China with its highest GDP in the world (ordinal number 1 for GDP) is only the 84th by GDP per capita at parity of purchasing capacity, the 636th out of 692 in 2013 and 573rd out of 639 in 2015 by the dynamics of market effectiveness. The gap between ordinal rank 84 and

effective in the dynamics of 2013-2015 shows that the degree of lagging behind Qatar the leader traditionally ranked 1st in both ordinal and effective rankings, is significantly more than 84 ranks;

- Another interesting result is that the degree of difference between the effective ranks of developed and developing countries is not so significant (if r^* of the United States in 2015 was equal to 371, India's r^* was 612 which is 1.65 times higher than the US rank; whereas ordinal ranks of these countries differ by 12.2 times). Nevertheless, in an effective ranking they are ranged consequently starting from economically developed countries in the first part and economically developing countries (with the Russian Federation at the top) in the second part of the list;

Table 3: Comparison of the results of the traditional and effective rankings of the leading countries in terms of GDP and GDP per capita

Countries of the world	Ordinal rank		Effective rank for GDP per capita		
	GDP	GDP per capita	2013	2014	2015
USA	2	10	437	393	371
Germany	5	18	475	432	414
France	10	24	499	458	442
United Kingdom	9	25	505	461	442
Japan	4	27	515	474	457
Russia	6	48	568	528	518
Brazil	7	76	616	575	566
People's Republic of China	1	84	636	589	573
Indonesia	8	99	646	601	588
India	3	122	669	624	612
Maximum number of ranks	208	208	692	649	639

- if we analyze the dynamics of effective ranks of the leading countries in GDP per capita in 2013-2015 (Table 4), it can be seen that the countries representation has not changed, as is the sequence of their enumeration by GDP per capita, while the degree of difference between countries with ordinal numbers 2-10 starting from the leader Qatar, differs

significantly more than traditional serial numbers, which means that we took into consideration the non-linearity of the countries distribution, and measured accurately the degree of differentiation of countries among themselves according to the index chosen for ranking;

Table 4: Effective ranks of the leading countries in GDP per capita in 2013-2015.

Nº/Nº	Leading countries by GDP per capita	2013	2014	2015
1	Qatar	1	1	1
2	Luxembourg	240	195	161
3	Macau (PRC)	45	45	166
4	Singapore	299	254	228
5	Brunei	295	272	256
6	Kuwait	345	316	301
7	Norway	374	332	310
8	United Arab Emirates	380	337	314
9	San marino	394	358	335
10	Switzerland	417	375	358
	Maximum number of ranks	692	649	639

- the reduction of the maximum number of effective ranks from 692 in 2013 to 639 in 2015 indicates high concentration of

countries with minimum and maximum values of GDP per capita (nonlinear groups of regions with the best and worst

values of the ranked indicator). Furthermore, no significant change in the slope of the curve has been detected, only its

length changes as a function of the change in the maximum r^* (Fig. 6);

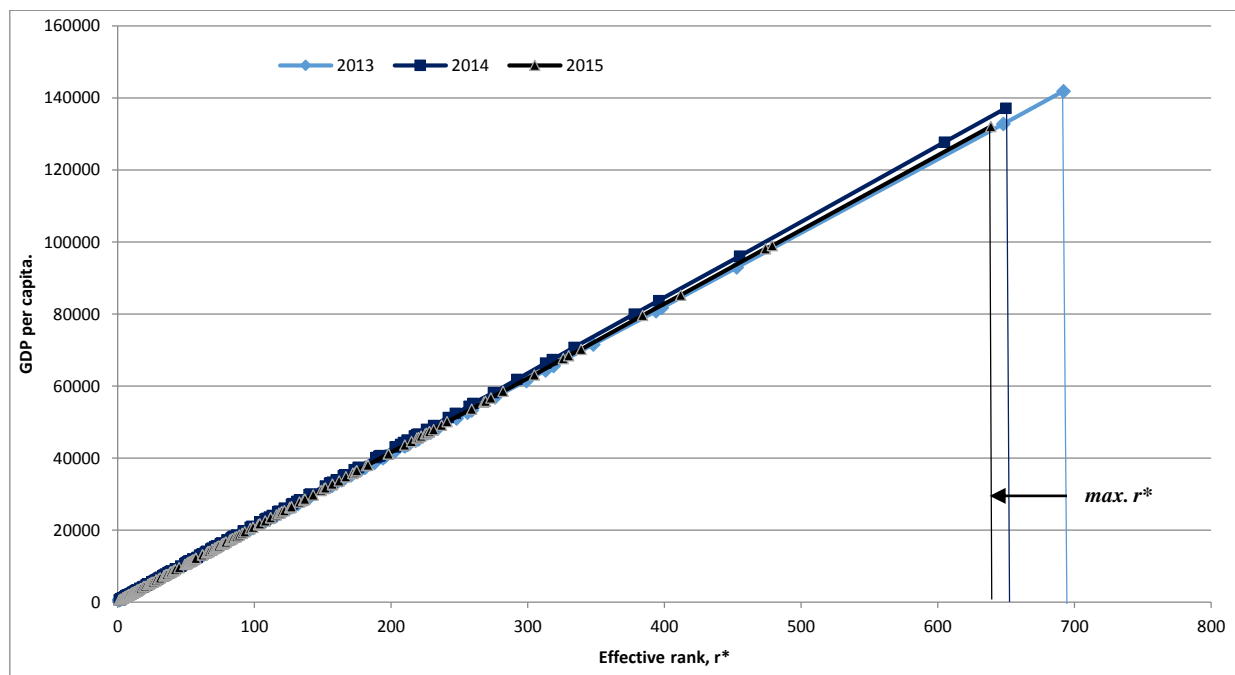


Figure. 6: Change in the curve of the linear distribution of countries by GDP per capita . using effective ranking

It is necessary to improve the ranking method of the country's distribution in the world economy with respect to the social and economic indicators of its development when adopting public economic policy. This will help to get a real idea of the country's place that achieved in the corresponding period of time, taking into account the "dispersion" of countries and regions among themselves because of existing disproportions in development expressed in nonlinear distribution of the

initial values of social and economic indicators. In this case, the state shall have a real indicator capable of assessing the effectiveness of public administration and determining the level of implementation of the development potential that the country possesses and whether it was (or was not) successfully implemented [5, p.46].

Table 5: The result of typology of objects for the purpose of ranking the rating results

N_2/N_2 type	Characteristics of the zone of social and economic development	Composition of countries included in the relevant type
Type I	Zone of the countries-leaders in financial, cultural, tourist, and social development	Sector D and Sector C
Type II	Zone of highly industrialized countries with high population density and a difficult ecological situation	Sector B
Type III	Zone of the raw material economy against the background of low population density and difficult climatic conditions	Sector A2
Type IV	Agrarian economy zone against the background of high density and attractive climatic conditions	Sector A1
Type V	Zone of highly subsidized territories with underdeveloped economies	Zero Sector

Fig. 7 presents a variant of countries ranking 5 selected types. This approach takes into account the differentiation of countries among themselves according to the type of

economy and is more accurate than the overall ranking.

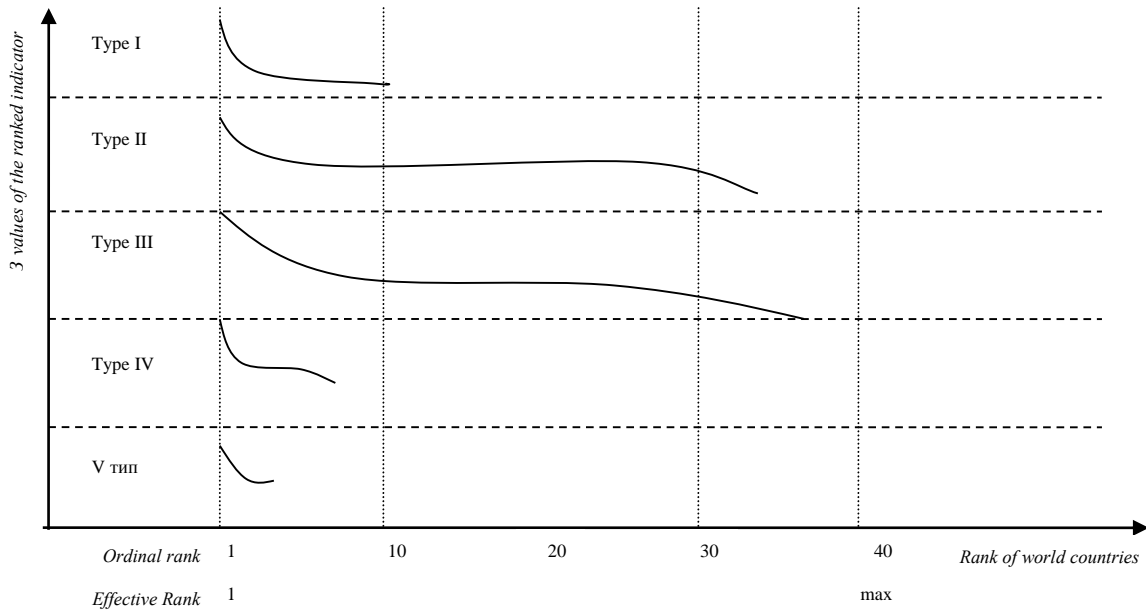


Figure 7: Multilevel ranking of the results of countries' rating by types of economic development

Using the presented method of effective ranking of the world's countries by GDP per capita and other indicators characterizing the result of their social and economic development, in the practice of ranking and rating used by the IMF, the World Bank, the UN is a real way to increase the reliability and relevance of this method and the results obtained in ascertaining the state of the world economy and the place, the role that each country in it occupies.

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