Vol. 20-2 (2020)

NATIONAL WEALTH STRUCTURE OF THE COUNTRIES OF THE WORLD, 2000–2014,AND ECONOMIC DEVELOPMENT GUZEV, M.M.* LEDENEVA, M.V. POLKOVNIKOV, A.A.

Abstract. The article shows the methodological and theoretical bases for the measurement of national wealth, accordingly to the World Bank reports. On the basis of a widening conception and the data of the World Bank the tendencies of changes in the dynamics and structure of national wealth in 91 countries of the world in 2000-2014 are shown. The clusters of the countries of the world with the most similar tendencies are formed with the help of a number of cluster formation methods. Besides we compare indicators of wealth and economic development and find a high positive correlation although with a few exceptions.

JEL Codes:

Keywords: national wealth, assessment methodology, human capital, natural capital, produced capital, structure, algorithm, cluster formation, cluster.

1. Introduction

The importance of the problem under analysis is determined by the necessity of the clarification of the place and role of specific factors in the growth of national wealth, its volume and dynamics of this wealth in various countries of the world for the development of an efficient strategy of economic policy.

The analysis of the existing methods of various elements of national wealth calculation and the assessment of its volume in general allows speaking about the priority of the methodology of the World Bank which became the basis of research allows making the cluster formation of the existing data.

The chosen algorithm and the used metrics were focused on the comparison of the volume and the structure of national wealth of 91 countries of the world according to the data of the World Bank what allows creating the main clusters which reflect the level of human, produced and national capital with a high reliability. The results of research can vary from the widely used data due to a new methodology of cluster formation of the data used by the authors.

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2. Literature Review

The issue of national wealth, its structure, sources of its formation is traditional for the economic theory. Before the conception of the added value appeared, the national wealth was the main indicator characterizing the production opportunities of the economy. The fundamental parameters of the theory of national wealth were developed in the papers of F. Quesnay, J. B. Clark, A. Marshall, J.S. Mill, V. Pareto, W. Petty, A. Smith, J.-B. Say and some others. The research of T. Ashirova, E. Bukhvald, R. Goldsmith, S. Valentey, L. Nesterov, N. Fedorenko had a significant impact on the study of content, composition, reproduction and measurement (assessment) of the national wealth and its main elements.

When speaking about the problem of the measurement of the national wealth we cannot but agree with E.M. Bukhvald that the total national wealth and moreover its dynamics cannot be presented as a mathematical sum of methodologically differentiated economic value assessments. We shouldn't be seduced by a simplification that it is enough to obtain the value assessment of this or that amount of natural resources this way or another, to add it mathematically to an estimation of other elements of national wealth so that we could find that the goal of the assessment of the cumulative value of the national wealth is achieved. Such a summation of the results of the methodologically differentiated measurements is not quite representative and even in the form of a moment assessment and when we speak about a long term forecast this sum tends to a zero reliability¹.

Today there exist two main directions in the assessment methodology of national wealth:

- traditional approach is based on the conception of "ecological and economic assets" published in the guidelines of the United Nations for the System of National Accounts, guidelines in the UN "Integrated Environmental and Economic Accounting" and also the classification of the nature protection activity;

- expansive conception of the World Bank.

The statistics of the national wealth according to the methodology of the System of National Accounts is formed as the statistics of national resources and it uses the methods of direct countingwhich use the inventory check data, accounting and statistical reports. According to this methodology the national wealth includes a set of economic assets. An economic asset is the accumulated value of wealth which gives an economic benefit or a number of economic benefits to the owner of the economic asset as the result of its ownership or its use during some period of time². Thus, the components of the national wealth are the objects which have the followingdistinctive determining features: legal entity or a household (institutional unit) has the right for the mentioned facility, its use on the basis of the property right gives the institutional unit the opportunity of getting the economic benefit, and the object has a monetary evaluation. The mentioned criteria do not allow including into the System of National Accounts a number of goods whose monetary evaluation and also the calculation of the profit obtained from them are

¹ National wealth under the conditions of market conditions' creation. Editor in Chief V.K. Faltsman, E.M. Bukhvald. Moscow: NaukaPubl., 1994. P. 10.

²TheSystemofNationalAccounts 2008. IMF., Commission of European Communities. OECD, UN, WorldBank. New York, 2009. P. 142.

complicated. For example, these arethe intangible forms of wealth when their bearer is a human (human capital) or society (social capital, institutional capital, intangible cultural and spiritual values) and also the natural capital the assessment of which is carried out irregularly. As a result the calculation of the national wealth is limited as a rule by the produced non-financial assets and the financial assets minus the debt obligations.

The difficulty in the calculation of the elements of national wealth by a traditional method encouraged the search of alternative ways of assessment. So, in the late 1990s the group of specialists of the World Bank (Kunte A., Hamilton A., Dixon J., Clemens M.) developed as an experiment an alternative method of the analysis of the structure of national wealth which was based on the rent assessment (approach)³. It is based on the definition of the national wealth as the total of three components: natural capital, produced capital and human resources. In further researches which were published in 2006⁴ (K. Bolt, K. Hamilton, A. Markandia, S. Pedroso-Galinato, J. Root, M. Said Ordubady, P. Silva, L. Tadzhibaeva) the term "human resources" was replaced by the term "intangible capital". When speaking about the human capital (the sum of knowledge and skills of the population, know-how) and also the quality of official (institutional infrastructure of the country, legal system, clear registration of property rights) and inoffical institutes (social capital). The researchers confirmed that the wealthy countries are rich specifically due to the qualification of their population and the quality of the institutes which gave support to the economic activity⁵. However in the research published in 2018 the authors returned again to the term "human resource" having entitled it as "human capital".

The method of the World Bank was firstly focused on the inter country comparisons that's why its authors had to make a number of significant simplifications. The produced assets were assessed in a traditional way on the basis of the regular inventory check which was carried out on the basis of monetary evaluation of the initial stock of assets, their wear and tear and investments. For the assessment of natural resources and human capital the income approach was used. So, the value of the land was calculated judging from the current value of the flow of income obtained in a limitless horizon period. The income from forest resources and minerals was also evaluated judging from the resource rent. The period of minerals' depletion was determined on the basis of the information about the explored reserves and the dynamics of the natural gas extraction which provided the maximal constant income flow. In case when the level of reserves was unknown a conventional term of the resources' depletion of 20 years was taken into account. The incomes from the extraction of oil, gas, iron ore, lead, nickel, phosphorites, zinc and stanum were analyzed.

The intangible capital was evaluated by the authors according to the "residual cost". The net national income produced due to natural resources was deducted from the total volume of net national income. After that the current value of the "non-resource"

³Kunte A., Hamilton A., Dixon J., Clemens M. Estimating National Wealth: Methodology and Results. The World Bank, Environmentally Sustainable Development, 1998.

⁴Where Is the Wealth of Nations? Measuring Capital for the 21th Century.TheWorldBank.WashingtonDC, 2006.

⁵Where Is the Wealth of Nations? Measuring Capital for the 21th Century. TheWorldBank. WashingtonDC, 2006. P. XIV.

net national income per an average number of years of the productive life of population (life expectancy for the first year of life minus average age of population) was calculated. From the product obtained in the result which can be produced by the population the sum of assets and land were deducted. The result of these operations was taken as the assessment of human resources. The confusion of various methodologies of the elements of national wealth is one of the constraining drawbacks of the World Bank methodology although within the System of National Accounts it can remain. In addition, the intangible capital includes the direct foreign assets which the country obtains or pays off. For instance, if a country is a debtor, so the interest of foreign debts leads to the reduction of consumption reducing by this the total wealth and consequently the intangible capital. And, finally the intangible capital includes the errors and lacunas in the evaluation of natural and produced capital. The largest part of lacunas are observed in the fishery and ground waters.

The method of the World Bank was adjusted by the Russian Scientists of the Institute of Economics of the Russian Academy of Sciences (S. Valentey, L. Nesterov, G. Ashirova) taking into account its critical analysis and its adaptation to the situation in Russia. The scientists made significant corrections in the evaluation of a number of the countries for which an incomplete information was used (for instance, OPEC countries) and the evaluations of national wealth for a number of CIS countries were carried out. In order to make the elements of the national wealth comparable the authors of the calculations in Russia made the assumption that there would be similar conditions of the market economy and world price levels at the evaluation of the corresponding indicators⁶.

The research of the World Bank in 2018 in contrast to an earlier period showed that the human capital is evaluated as an evident element of the wealth accounts for every country. The World Bank developed a unique global data base of more than 1500 surveys of households which give the basis for a global introduction of a well-known approach of D. W.Jorgenson, and B. M. Fraumeni as a necessary earning for a living for the development of human capital⁷.

3. Methods of Research

The group of specialists from the World Bank made the experimental assessments of human, natural and produced capital accumulated in the world and calculated per capita in 92 countries of the world (Russia was excluded from the analysis) asof 1994 and then in 118 countries of the world where 5,3 billion people live as of 2000, in 149 countries of the world as of 2005 and then in 140 countries as of 2014.

The goal of the present research was the identification of the tendency of percentage change of natural, human and produced capital of the countries studied by the specialists of the World Bank for the period 2000–2014 (91 countries) and then to create the clusters from the countries with similar observed tendencies.

One of the main goals of machine teaching and in particular of data analysis it

⁶ValenteyS.D., NesterovL.I. Nakoplenie natsionalnogo bogatsva. Rossiya na fone mirovykh tendentsiy [Accumulation of national wealth. Russia at the back of world tendencies]. Moscow.: Institute of Economics of RAS Publ., 2000.

⁷Lange, G.M., Wodon, Q., Carey K. The changing wealth of nations 2018: Building a Sustainable Future. World Bank Group. WashingtonDC, 2018. P. 28.

is the goal of cluster formation i.e. the division of the data in groups in the way so the points which are very similar are included into one cluster and those which are seriously different are included into various groups⁸. The structure of the available data is presented by three parameters among which it is necessary to assess their possible dependence on each other. That's why as the basis of presentation of the data the barycentric coordinates were taken what allowed visualizing and forming clusters from the available data. The results of cluster formation depend not only on the chosen algorithm but also on the used metrics (distance measurement) between two points. Three variants of metrics are used in the research: Euclidian (standard) metrics, minimum out of the distances to the boundaries of a triangle and simulation of normal lines of the points.

In the given paper several methods of cluster formation are used:

1) K-means is the simiplest algorithm of cluster formation which was suggested in 1950s by the mathematicians Hugo Steinhauser and Stewart Lloyd (independently from one another). The mentioned algorithm divides an assemblage of elements of the space into a well-known number of clusters k. The principle of the work of the algorithm is as follows:

1. The projected centers of clusters (so called "centroids");

2. The distances from every point to every center are measured;

3. The points are divided into clusters (minimal distance from a point to the cluster center) (1):

$$V = \sum_{i=1}^{k} \sum_{x \in S_i} (x - \mu_i)^2$$
(1)

where k – number of clusters, Si – the obtained clusters, i = 1, 2, ..., k, a μi – mass centers of all the vectors x from the cluster Si.

4. Then for every obtained cluster the center of mass is reevaluated again and correspondingly, the cluster center is dislocated and the algorithm starts a new itinerary. The process is finished at the moment when the changes of the centers do not take place and new itineraries do not generate more changes.

The popularity of this algorithm is determined not only by its simplicity but also by a comparatively high speed of work⁹. The disadvantages of the method consist, first of all, in the fact that the number of clusters should be known in advance and the result depends on the initial choice of the cluster centers. There is no formal approach to the determination of the number of clusters and it is one of the variants of the use of the "elbow method". This method supposes the construction of the homogeneity function or heterogeneity of a cluster. The point in which the homogeneity function changes its behaviour can be seen as an optimal one. The measure of homogeneity can be the distance from a point to a cluster center. Second, the algorithm is incapable of identifying the cluster of an irregular sign and moreover the clusters of various forms what can lead to unexpected results. Third, the initial points of clusters are set by random what leads to the situation that a new beginning of the algorithm can give another result. The

⁸MuellerA., GuidoS. Vvedenie v mashinnoe obuchenie s pomoshchyu Python [Introduction into machine teaching with the help of Python]. Moscow: Publishing House Gevissta Publ., P. 85.

⁹Ibid., P. 198.

program uses the implementation of this method from sklearn library in the programming language Python.

2) The methods of hierarchy analysis or hierarchy cluster formation. The basis of the method is the construction of a hierarchy (tree) of the nested clusters. The basis of the method is the construction of the hierarchy (tree) of the nested clusters. There exist two variants of the implementation of the algorithm of the hierarchy analysis i.e. the agglomerative and divisional methods. In the thirst case the construction leads from particulars to generals i.e. initially every point presents the clusters and further the points are united forming new clusters and in division methods the clusters are constructed according to the principle "from generals to particulars" i.e. one large cluster consequently is divided into clusters of a smaller size. For the functioning of the algorithm the unknown number of clusters should be known.

Generally the agglomerative methods of a tree construction are used. In order to determine which points will be included into the cluster the following methods are used:

Singlelinkage(method of the nearest neighbour). The minimal distance between the points from various clusters.

Completelinkage(method of the furthest neighbour). The maximal distance between the points from various clusters.

The pair-group method using the arithmetic mean. A mean distance between the neighbouring clusters.

The centroidal method. The distance between clusters is the distance between their centroidals (mass centers).

The Ward method which shows the minimal growth of the dispersion inside of clusters.

In dependence on the chosen criteria of the relation there will be various results of cluster formation. The Ward criteria is convenient in most cases if it is not supposed that the clusters vary seriously according to the size¹⁰. It is worth mentioning that the agglomerative method copes much better with the data of various form and size than KMeans but it does not do it very good.

3)DBScanis the spatial cluster formation for the applications with noise (Density-basedspatialclusteringofapplicationswithnoise). As we can judge from the title the given algorithm is based on the density of the location of points. The most densely located points will create the clusters. In addition, DBScan has two important advantages: capability of the identification of clusters of irregular form and opportunity of identification the "noise of the point which are not included into any cluster" ¹¹. For the given algorithm two input values are necessary, they are the maximal remoteness of the "neighbour" in cluster (eps) and a minimal number of points which form a cluster (min samples).

The algorithm works in the following manner: a random point is selected and the reachable points in eps radius are marked. If the number of such points is lower than min_samples, the point is considered as a noise. If not it gets a mark of a new cluster and its "neighbours" undergo the same procedure. The peculiarity consists in the fact that in

¹⁰Mueller A., Guido S. Vvedenie v mashinnoe obuchenie s pomoshchyu Python [Introduction into machine teaching with the help of Python]. Moscow: Publishing House Gevissta Publ., P. 199.
¹¹Ibid., P. 204.

some cases the points remain contiguous and can be included into various clusters. All other points in every new beginning of the algorithm will remain in their places.

4. Results

The authors compared the amount and the structure of the national wealth of 91 countries of the world according to the data of the World Bank. If we compare the countries of the world according to the value of wealth per capita, thus in 2000 and in 2014 the first ten of the countries looked as follows (Table 1). As we can see in Table 1, the list of the countries changed by 50%. Norway improved its position, having moved 7 ranks upwards and having got the 1st rank in 2014. Australia and Canada which in 2000 were not included into the first ten, in 2015 had the 3rd and 4th ranks according to the amount of national wealth per capita. The positions of Denmark, Germany, France, Austria and Japan worsened. As for the Russian Federation it moved from the 42nd rank in 2000 to rank 30th in 2014.¹²

| | Wealth per capita2000 | Wealth percapita2014 | | |
|----|-----------------------|----------------------|--|--|
| 1 | Switzerland | Norway | | |
| 2 | Denmark | Switzerland | | |
| 3 | Sweden | Australia | | |
| 4 | USA | Canada | | |
| 5 | Germany | USA | | |
| 6 | Japan | Sweden | | |
| 7 | Austria | Denmark | | |
| 8 | Norway | Netherlands | | |
| 9 | France | Singapore | | |
| 10 | Belgium-Luxemburg | Germany | | |

Table 1. The top ten of countries according to National Wealth per capita

Source: World Bank.

If we analyze the absolute growth of national wealth per capita, so we can say that the maximal amount was observed in the countries with a low value of this indicator among which the countries of Africa predominate. Thus, in the Republic of Congo the amount of wealth per capita grew 19,5 times, in Nigeria it increased 13,6 times, in China it grew 11,3 times, in Ethiopia and Zambia this indicator increased 6 times, in Malaysia and Latvia it grew 5 times, in Russia it increased 4,8.

On the other hand, three countries (Greece, Argentina and Gambia) had a negative growth of national wealth. In average the amount of national wealth per capital in the set of the countries under analysis grew from 92407,1 US dollars per capita to 176932,2 US dollars or 1,9 times.

For the analysis of the structure of national wealth of the countries of the world the authors formed the clusters by means of three methods: K-means or methods of hierarchy analysis and DBScan with the use of three metrics: Euclidian (standard), minimum of distances to the boundaries of a triangle and multiplication product of points' normals.

¹²Calculated by the authors using the data: Where Is the Wealth of Nations? Measuring Capital for the 21th Century. 2006. TheWorldBank.WashingtonDC; Lange, G. M.; Wodon, Q.; Carey K. 2018. The changing wealth of nations 2018: Building a Sustainable Future. World Bank Group. WashingtonDC.

The most interesting is the cluster formation by means of the K-means method with the use of Euclidian metrics which is presented in Figures 1 and 2.



Human capital

Figure 1. Countries' cluster formation by means of the method K-means with the use of Euclidian metrics, 2000.Cluster 1 is violet, Cluster 2 is aquamarine, Cluster 3 is yellow, Cluster 5 is green.



Figure 2. Countries' cluster formation by means of the method K-means with the use of Euclidian metrics, 2014Cluster 1 is violet, Cluster 2 is aquamarine, Cluster 3 is yellow, Cluster 5 is green.

The result of this method's use became the formation of 5 clusters (Table 2) the main characteristics of which became the level of human capital to which various levels of produced and natural capitals can correspond. In general in all countries the share of human capital grew what is reflected in the shift of points in the lower axis to the right. In 2014 the countries with zero or negative human capital are absent.

The dynamics of cluster formation of shares of national wealth of the countries of the world allowed identifying 5 clusters (Table 3). In comparison with year 2000, in 2014 39 countries out of 91 countries of the world remained in the same clusters, 52 moved to another cluster. At the same time judging from the obtained data a more significant mixture of various countries is observed which are grouped into various subgroups according to economic and social development.

| | Table 2. Cluster obtained by the I | x-means memous with the use of | |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | 2000 | 2014 | Cluster characteristics |
| Cluster 1 | <i>Nigeria</i> , Surinam | Guiana, Mauritania, Mali, Niger, Surinam | The natural capital predominates; the share of produced and human capital is low. The cluster includes the developing countries of Africa and South America which specialize in extraction and export of natural resources. |
| Cluster 2 | Venezuela, Gabon, Guiana, Republic of Congo, Moldova, Russian Federation | Belize, Burkina-Faso, Gabon, Zambia, Cameroon, Congo, Ivory Coast, Madagascar, Malavi, Mozambique, Nepal, Chad | The share of human capital is relatively low, average share of natural and produced capital is medium. The cluster includes the developing countries, mainly the poor ones. The composition of the cluster significantly changed; in 2014 it included mainly the countries of Africa. |
| Cluster 3 | Burundi, <i>Honduras, India,</i> <i>Cameroon, China, Mauritania,</i> <i>Madagascar, Mali, Nepal, Niger,</i> Rwanda, <i>Chad</i> , Ecuador, Ethiopia | Albania, Bolivia, Botswana, Burundi, Venezuela, Haiti, Gambia, Ghana, Egypt, Zimbabwe, India, Kenya, Comoro Islands, Morocco, Nigeria, Nicaragua, Peru, Russia, Rwanda, Senegal, Ecuador, Ethiopia | Low or average share of produced and natural capital, medium share of human capital. The cluster includes the developing countries. |
| Cluster 4 | Albania, Bangladesh, Belize, Bolivia, Botswana, Burkina- Faso, Egypt, Zambia, Zimbabwe, Indo-nesia, Canada, Kenya, Columbia, Comoro I., Costa- Rica, Ivory Coast, Latvia, Malawi, Malaysia, Mexico, Moz- ambique, Nicaragua, Norway, Pakistan, Paraguay, Romania, Thailand, Chile, Estonia | Australia, Argentina, Bangladesh, Brazil, Gua- temala, Honduras, Greece, Georgia, Indonesia, Jordan, China, Latvia, Mexico, Moldova, Namibia, Pakistan, Paraguay, Romania, Thai- land, Philippines, Chile, Rep. of South Africa, Jamaica | The human capital predominates (55-85%); 10–20% are accounted for natural and produced capital. |
| Cluster 5 | Australia, Austria, Argentina, Belgium-Luxembourg, Brazil, UK, Hungary, Haiti, Gambia, Ghana, Guatemala, Germany, Greece, Georgia, Denmark, Dominican R, Jordan, Ireland, Spain, Italy, Rep. of Korea, Morocco, Namibia, Nether- lands, Peru, Portugal, Salvador, Senegal, Singapore, USA, Uruguay, the Philippines, Finland, France, Switzerland, Sweden, Sri-Lanka, Rep. of South Africa, Jamaica, Japan | Austria, Belgium&Luxem- burg, UK, Hungary, Germany, Denmark, Domi-nican R, Ireland, Spain, Italy, <i>Canada,</i> <i>Columbia</i> , Rep. of Korea, <i>Costa-Rica, Malaysia</i> , Netherlands <i>Norway</i> , Portugal, El Salvador, Singapore, USA, Uruguay, Finland, France, Switzerland, Sweden, Sri-Lanka, <i>Estonia</i> , Japan | About 80% of national wealth is accounted for the human capital; 10–15% is accounted for the produced capital, the natural capital has a low importance. The cluster includes the highly developed countries and developing countries which are not rich in natural resources. This is the most stable cluster. |

| T 11 0 Cl + 1+ 11 | 4 10 4 1 | · a . a | CE L'IL |
|------------------------------|-----------------------|-----------------|----------------------|
| Table 2. Cluster obtained by | y the K-means methods | with the use of | of Euclidian metrics |

* - the countries which changed the cluster are put in italics

| | Country | Characterof the shift | | |
|---------|----------------------------------------------------|--------------------------------------|--|--|
| Cluster | Indonesia, Malaysia, Norway, Moldova, Gabon, | The share of produced capital is | | |
| 1 | Congo, Republic of Venezuela, Russian Federation, | practically unchanged, the | | |
| | Guyana, Honduras, China, Cameron, Burundi, | distribution of shares is observed | | |
| | Rwanda, Singapore, Nigeria | between the human and natural | | |
| | | capital. | | |
| Cluster | Bangladesh, Romania, Costa-Rica, Albania, | The reduction of share of human | | |
| 2 | Argentina, Greece, Georgia, Jamaica, Austria, | capital, growth of share of produced | | |
| | Belgium-Luxemburg, UK, Hungary, Germany, | capital, small growth of share of | | |
| | Denmark, Dominican Republic, Ireland, Spain, | natural capital. | | |
| | Italy, Republic of Korea, Netherlands (Holland), | | | |
| | Portugal, USA, Uruguay, Finland, France, | | | |
| | Switzerland, Sweden, Sri-Lanka, Japan, Haiti | | | |
| Cluster | Burkina-Faso, Malawi, Botswana, Egypt, | Insignificant reduction of the share | | |
| 3 | Zimbabwe, Mali | of produced capital, significant | | |
| | | growth of share of natural capital, | | |
| | | significant reduction of human | | |
| | | capital share. Transfer into the | | |
| | | cluster with a lower share of human | | |
| | | capital. | | |
| Cluster | Pakistan, Paraguay, Thailand, Chile, Belize, | Growth of share of natural and | | |
| 4 | Zambia, Ivory Coast, Mozambique, Bolivia, Kenya, | produced capital at a significant | | |
| | Comoro Islands, Nicaragua, Madagascar, Nepal, | reduction of the share of human | | |
| | Chad, Mauritania, Niger, Australia, Brazil, | capital. | | |
| | Guatemala, Jordan, Namibia, the Philippines, | | | |
| | Republic of South Africa, Salvador, Gambia, Ghana, | | | |
| | Morocco, Peru, Senegal | | | |
| Cluster | Latvia, Mexico, Canada, Columbia, Estonia, India, | A significant growth of share of | | |
| 5 | Ecuador, Ethiopia, Surinam | produced capital, some reduction of | | |
| | | natural capital share, reduction of | | |
| | | human capital share. | | |

Table 3. Cluster formation in dynamics of shares of national wealth of the countries of the world obtained by the K-means method with the use of Euclidian metrics

5. Wealth and economic development around the World in year 2015

Economic development measured by Gross Domestic Product per capita is usually an important indicator of wellbeing because high levels of this variable usually imply high levels of health assistance, education, labor productivity, women empowerment, quality of government and other positive features as seen in Guisan and Neira(2006), who highlight the positive impact of human capital, and in other studies.

Gross Domestic Product (GDP) depends on demand and supply, having into account, according to Guisan(2009), not only the supply of primary inputs but also the supply of intermediate inputs (given by domestic production of industrial and other intermediate goods and the capacity to export and import).

In Figure 1 of the study by Guisan(2009) appears the interrelationships between Human Capital, Social Capital, Physical Capital, Natural Resources, Industry, Non Industrial Production and Foreign Trade in order to contribute to sustainable increase of domestic income per capita.

Accordingly to these author, Human Capital and Physical capital per capita are very much related, and here we find also a close relationship between "Produced Wealth" and "Intangible Wealth" per capita.

In the Annex we include data of Wealth per capita and ranking positions, for the 91 countries of this study, of Wealth per capita (WH) and GDP per capita (PH). There, we present a table of correlation of PH with WH and with its componentsWH1 (Produced capital per capita), WH2 (Natural capital per capita) andWH3 (Intangible (human) capital per head). The correlation is high with WH, WH1 and WH3 but lower with WH2.

Here, in table 3 we present the coefficients of correlation between PH and any of the variables WH, WH1 and WH3, for groups of countries with different levels of Production per capita (PH).

| | Groups of countries accordingly to value of PH in year 2015 (USD at 2011 PPPs) | | | | | | | | | |
|-----|--------------------------------------------------------------------------------|------------|-------------|-------------|--------|--------|--|--|--|--|
| | <5000 | 5000-10000 | 10000-30000 | 30000-40000 | >40000 | All | | | | |
| WH | 0.8021 | 0.4901 | 0.7863 | 0.9784 | 0.3344 | 0.9070 | | | | |
| WH1 | 0.7627 | 0.4891 | 0.7272 | 0.7831 | 0.0824 | 0.9112 | | | | |
| WH3 | 0.7863 | 0.6694 | 0.7699 | 0.9643 | 0.2829 | 0.9009 | | | | |

| Ta | ıbl | le 3 | 6. C | Correl | lation | coeff | icients | of | PH | with | WH, | WH1 | and | WH3 |
|----|-----|------|------|--------|--------|-------|---------|----|----|------|-----|-----|-----|-----|
|----|-----|------|------|--------|--------|-------|---------|----|----|------|-----|-----|-----|-----|

Note: Elaboration from data in table A1 of the Annex.

There is a high positive correlation between PH and the variables WH, WH1 and WH3, in all the groups but the countries with PH higher than 40000. Produced capital and human capital are also important for economic development in high income countries, but in some case there are special circumstances related with the role of foreign trade, domiciliation of international companies, net international investment position (NIIP), or other ones, that may explain that PH may be higher or lower than expected accordingly to the level of WH. Figure 3 shows the positive relationship between PH and WH.



The estimated linear equation of PH as a function of WH is:

 \wedge

PH(i) =
$$6492 + 0.0464$$
 WH (i);
(6.85)* (20.32)* for i= 1,2,...,91

Where the terms within parentheses are t-student coefficients, which are high and show the significant effect of the coefficients.Goodness of fit: $R^2 = 0.8227$; % Standard Error on Mean=42%. Durbin-Watson statistic: 1.91

The results show that the value of WH has a positive and significant impact on PH, but there are other factors that can help to improve the goodness of fit, particularly regarding the % of the Standard Error on the Mean of PH.

6. Conclusions

1. On the basis of the data obtained by the specialists of the World Bank it was established that according to the amount of national wealth per capita from 2000 to 2014 the first ten of the countries of the world changed considerably although it were as earlier and they are industrially developed countries of the world. The total growth was 1,9 times.

The first ten according to the absolute growth of national wealth per capita for this period consisted of the countries from various continents with low initial indicators and Russia is included into this group. The growth of the indicator mentioned above in Russia made up 4,8. For comparison, this indicator in China made up 11,3 times. There are countries (Greece, Argentina, Gambia) with a negative growth (reduction) of national wealth.

2. The tendencies of the change of the share of national, human and produced capital in the national wealth of 91 countries of the world from 2000 to 2014 were identified. The analysis of the structure of national wealth was carried out with the help of the following methods: K-means, method of hierarchy analysis and DBScan with the use of three metrics (standard), minimum of distances to the boundaries of a triangle and result of multiplication of points' normals allowed identifying 5 clusters and calculating the growth of human capital share of the countries under analysis. TheKmeans method is the simplest and the most widely used algorithm of cluster formation but as the initial points of clusters are set at random, every its beginning can generate other, contradicting results. In particular, according to the obtained results, the Russian Federation still in 2000 being in the 2nd cluster with a low level of human capital was in the same cluster with such countries like Venezuela, Gabon, Moldova. And in 2014 when Russia was in the 3rd cluster with a "relatively low level of human capital" together with Albania, Botswana, Nicaragua, Peru, Zimbabwe, Morocco. At the same time Estonia, for instance which is famous for the emigration of qualified personnel was placed into the 5th cluster with a high share of human capital. That's why the data of research can be the information for reflection but not a final result.

3. The cluster formation according to the shift, obtained by means of the method K-means with the use of Euclidian metrics also allowed identifying 5 clusters. At the same time in comparison with 2000 in 2014 39 countries out of 91 remained in the same clusters and 52 countries moved into another one. In this case the obtained results can be characterized by a higher uncertainty. So, in the 2nd cluster which was characterized by the "reduction of the human capital share" the USA, Finland, Germany, Netherlands, Italy, Switzerland, Republic of Korea, Japan and also Bangladesh, Romania, Albania, Sri-Lanka, Jamaica were included. But the Russian Federation which had a relatively unchanged structure of national wealth remained in the 1st cluster next to Norway,

China, Malaysia, Singapore and even Indonesia, Congo, Venezuela, Honduras, Burundi and Nigeria. All this allows studying from different points of view the main tendencies in the development of the structure of national wealth of the countries of the world and what is the most important, its significance for the development of the country.

4. The clusters created from the countries with similar observed tendencies and the structure of national wealth and for which the main characteristics became the amount of human capital allow emphasizing both the rank of various countries in the "cluster hierarchy" and their dynamics which become the starting point for a further thorough research of tendencies of share change of natural, human and produced capital and also for the identification of the factors of these changes what can become a certain basis for taking positive decision in the social and economic development of the country.

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Annex

Table A1. Wealthper capita (WH)and Population in 2014 and GDP per capita (PH) in 2015

| | Country | WH | WH1 | WH2 | WH3 | PH | Рор | rwh | rph |
|----|---------------|---------|--------|--------|--------|-------|---------|-----|-----|
| 1 | Albania | 53107 | 18808 | 13375 | 22818 | 11025 | 2894 | 52 | 45 |
| 2 | Argentina | 126516 | 37869 | 16185 | 71429 | 19101 | 42980 | 36 | 31 |
| 3 | Australia | 1046785 | 311442 | 180792 | 585737 | 43832 | 23461 | 3 | 10 |
| 4 | Austria | 694616 | 256744 | 16266 | 421849 | 44075 | 8542 | 12 | 9 |
| 5 | Bangladesh | 12714 | 3434 | 2234 | 7170 | 3133 | 159078 | 83 | 73 |
| 6 | Belgium+Lux | 676299 | 218835 | 5198 | 427492 | 41723 | 11788 | 13 | 13 |
| 7 | Belize | 58872 | 12303 | 29835 | 23969 | 6224 | 352 | 51 | 61 |
| 8 | Bolivia | 49235 | 6626 | 17527 | 24805 | 6532 | 10562 | 54 | 60 |
| 9 | Botswana | 95797 | 19908 | 26140 | 47087 | 15356 | 2220 | 42 | 33 |
| 10 | Brazil | 188883 | 32067 | 36978 | 123696 | 14666 | 206078 | 29 | 37 |
| 11 | Burkina Faso | 12323 | 1754 | 5755 | 4970 | 1551 | 17589 | 84 | 85 |
| 12 | Burundi | 7579 | 486 | 2704 | 4496 | 749 | 10817 | 90 | 91 |
| 13 | Cameroon | 31398 | 3768 | 13557 | 14414 | 2991 | 22773 | 67 | 74 |
| 14 | Canada | 1016593 | 229999 | 52438 | 730832 | 42983 | 35545 | 4 | 12 |
| 15 | Chad | 20077 | 1619 | 9973 | 9099 | 2048 | 13587 | 74 | 79 |
| 16 | Chile | 237713 | 45096 | 55113 | 139512 | 22537 | 17763 | 25 | 28 |
| 17 | China | 106172 | 28566 | 15133 | 63369 | 13570 | 1364270 | 39 | 38 |
| 18 | Colombia | 129289 | 27857 | 15932 | 87674 | 12985 | 47791 | 35 | 41 |
| 19 | Comoros | 8836 | 2585 | 2898 | 3402 | 2537 | 770 | 88 | 76 |
| 20 | Congo, R | 68779 | 15401 | 32843 | 25906 | 5543 | 4505 | 49 | 64 |
| 21 | Costa Rica | 166985 | 24681 | 24160 | 122640 | 14914 | 4758 | 31 | 35 |
| 22 | Cote d'ivoire | 24485 | 4391 | 11016 | 8986 | 3251 | 22157 | 71 | 72 |
| 23 | Denmark | 854331 | 273019 | 16261 | 538947 | 45484 | 5643 | 7 | 8 |
| 2 | Dominican R | 97257 | 21808 | 6219 | 73055 | 13372 | 10406 | 41 | 39 |
| 25 | Ecuador | 102451 | 20469 | 30007 | 52696 | 10777 | 15903 | 40 | 47 |
| 26 | Egypt | 38470 | 5605 | 11229 | 22591 | 10096 | 89580 | 63 | 49 |
| 27 | El Salvador | 44131 | 10216 | 4554 | 31951 | 7845 | 6108 | 59 | 55 |
| 28 | Estonia | 258903 | 91646 | 20093 | 155041 | 27329 | 1315 | 22 | 21 |
| 29 | Ethiopia | 13125 | 1347 | 5284 | 6723 | 1533 | 96959 | 81 | 86 |
| 30 | Finland | 726422 | 248986 | 18037 | 460082 | 38994 | 5462 | 11 | 14 |
| 31 | France | 641707 | 223830 | 11109 | 415851 | 37766 | 66269 | 15 | 17 |
| 32 | Gabon | 199901 | 34697 | 95461 | 62233 | 13297 | 1688 | 28 | 40 |
| 33 | Gambia | 5208 | 1545 | 1413 | 2745 | 1765 | 1928 | 91 | 82 |
| 34 | Georgia | 44327 | 20415 | 7344 | 21251 | 9025 | 3727 | 58 | 51 |
| 35 | Germany | 729064 | 236891 | 7701 | 467668 | 43784 | 80963 | 10 | 11 |
| 36 | Ghana | 25044 | 3768 | 8418 | 13853 | 3930 | 26787 | 70 | 69 |
| 37 | Greece | 227925 | 134895 | 12546 | 105663 | 24095 | 10892 | 27 | 26 |
| 38 | Guatemala | 43140 | 9555 | 8997 | 25450 | 7293 | 16015 | 60 | 57 |
| 39 | Guyana | 69971 | 12353 | 39620 | 21801 | 7377 | 764 | 48 | 56 |
| 40 | Haiti | 15040 | 5989 | 3018 | 6135 | 1651 | 10572 | 79 | 84 |
| 41 | Honduras | 44778 | 8427 | 10599 | 27372 | 4311 | 7962 | 57 | 68 |
| 42 | Hungary | 165519 | 65561 | 6623 | 102557 | 24831 | 9866 | 32 | 24 |
| 43 | India | 18211 | 5161 | 4739 | 8755 | 5754 | 1295292 | 77 | 62 |
| 44 | Indonesia | 46919 | 15299 | 9443 | 23701 | 10368 | 254455 | 55 | 48 |
| 45 | Ireland | 627256 | 189309 | 15912 | 473656 | 60944 | 4617 | 16 | 3 |
| 46 | Italy | 427466 | 188055 | 8619 | 241350 | 34245 | 60789 | 18 | 18 |
| 47 | Jamaica | 71766 | 30313 | 6804 | 41884 | 8105 | 2783 | 47 | 54 |
| 48 | Japan | 571927 | 179227 | 3741 | 365157 | 37818 | 127132 | 17 | 16 |

Applied Econometrics and International Development

Vol. 20-2 (2020)

| 49 | Jordan | 49287 | 17577 | 8876 | 27312 | 8491 | 7416 | 53 | 53 |
|----|--------------|---------|--------|--------|---------|-------|--------|----|----|
| 50 | Kenya | 19412 | 3356 | 6771 | 9556 | 2836 | 44864 | 75 | 75 |
| 51 | Korea, R | 424052 | 126650 | 4013 | 291748 | 34178 | 50424 | 19 | 19 |
| 52 | Latvia | 236906 | 113746 | 18738 | 113472 | 23057 | 1994 | 26 | 27 |
| 53 | Madagascar | 9237 | 919 | 4964 | 3784 | 1376 | 23572 | 87 | 87 |
| 54 | Malawi | 10442 | 939 | 5642 | 4003 | 1089 | 16695 | 86 | 89 |
| 55 | Malaysia | 239203 | 29989 | 28657 | 180729 | 24989 | 29902 | 24 | 23 |
| 56 | Mali | 17165 | 1999 | 11041 | 4334 | 1919 | 17086 | 78 | 80 |
| 57 | Mauritania | 29380 | 4891 | 17574 | 9368 | 3602 | 3970 | 69 | 71 |
| 58 | Mexico | 110471 | 39918 | 14629 | 59334 | 16668 | 125386 | 37 | 32 |
| 59 | Moldova | 35380 | 14213 | 4898 | 17852 | 4747 | 3556 | 66 | 66 |
| 60 | Morocco | 40488 | 13616 | 12372 | 16490 | 7286 | 33921 | 62 | 58 |
| 61 | Mozambique | 7718 | 1212 | 4136 | 3486 | 1118 | 27216 | 89 | 88 |
| 62 | Namibia | 84398 | 12696 | 18501 | 52458 | 9913 | 2403 | 44 | 50 |
| 63 | Nepal | 14368 | 2334 | 5545 | 6402 | 2301 | 28175 | 80 | 77 |
| 64 | Netherlands | 792396 | 234415 | 9528 | 516543 | 46354 | 16865 | 8 | 6 |
| 65 | Nicaragua | 37084 | 9075 | 13505 | 16698 | 4961 | 6014 | 65 | 65 |
| 66 | Niger | 11623 | 2369 | 8490 | 1041 | 897 | 19114 | 85 | 90 |
| 67 | Nigeria | 37408 | 3851 | 12963 | 20934 | 5671 | 177476 | 64 | 63 |
| 68 | Norway | 1671756 | 423905 | 103184 | 1004649 | 63670 | 5137 | 1 | 2 |
| 69 | Pakistan | 22182 | 3029 | 5982 | 13587 | 4695 | 185044 | 72 | 67 |
| 70 | Paraguay | 85575 | 11868 | 21358 | 54026 | 8639 | 6553 | 43 | 52 |
| 71 | Peru | 81931 | 19522 | 24914 | 39502 | 11768 | 30973 | 45 | 43 |
| 72 | Philippines | 30823 | 7860 | 5644 | 17790 | 6875 | 99139 | 68 | 59 |
| 73 | Portugal | 274453 | 117409 | 9189 | 172183 | 26548 | 10401 | 21 | 22 |
| 74 | Romania | 107022 | 41163 | 17265 | 54014 | 20538 | 19909 | 38 | 29 |
| 75 | Russian Fed. | 188715 | 48807 | 46921 | 90812 | 24124 | 143820 | 30 | 25 |
| 76 | Rwanda | 21619 | 1538 | 6650 | 13649 | 1716 | 11342 | 73 | 83 |
| 77 | Senegal | 13085 | 3736 | 3784 | 6260 | 2297 | 14673 | 82 | 78 |
| 78 | Singapore | 775196 | 186017 | 56 | 466119 | 80892 | 5470 | 9 | 1 |
| 79 | South Africa | 77348 | 19263 | 13743 | 44921 | 12425 | 54147 | 46 | 42 |
| 80 | Spain | 342470 | 142821 | 10298 | 215593 | 32216 | 46481 | 20 | 20 |
| 81 | Sri Lanka | 44970 | 11352 | 3247 | 32410 | 11062 | 20771 | 56 | 44 |
| 82 | Suriname | 161690 | 46402 | 86572 | 30782 | 14875 | 538 | 34 | 36 |
| 83 | Sweden | 886129 | 285792 | 27890 | 576521 | 45488 | 9696 | 6 | 7 |
| 84 | Switzerland | 1466757 | 356075 | 8531 | 1022950 | 56511 | 8189 | 2 | 4 |
| 85 | Thailand | 62599 | 20380 | 10144 | 33573 | 15237 | 67726 | 50 | 34 |
| 86 | UK | 647694 | 193456 | 7592 | 457223 | 38509 | 64613 | 14 | 15 |
| 87 | UnitedStates | 983280 | 216186 | 23624 | 766470 | 52790 | 318907 | 5 | 5 |
| 88 | Uruguay | 254601 | 64249 | 22001 | 171310 | 19831 | 3420 | 23 | 30 |
| 89 | Venezuela | 162560 | 70151 | 38151 | 49332 | 10973 | 30694 | 33 | 46 |
| 90 | Zambia | 40965 | 7139 | 16305 | 17549 | 3627 | 15721 | 61 | 70 |
| 91 | Zimbabwe | 18958 | 2704 | 7387 | 9877 | 1891 | 15246 | 76 | 81 |

Notes: WH is Wealth per capita in Dollars in year 2014; WH1 is "Produced Capital per capita", WH2 is "Natural Capital per capita", WH3 is "Intangible (human) Capital per capita, Pop is Population (thousand people). Source: World Bank. PH is Gross Domestic Product per capita a in year 2015 (in Dollars at 2011 Parities) f Guisan(2017) and World Bank.RWH and RPH: rankings of WH and PH. Data for Venezuela correspond to year 2010.

Some outstanding discrepancies between RWH and RPH are those of Canada, Ireland and Singapore, explained by special circumstances related with foreign trade, domiciliation of international companies or other factors. Table A2 presents correlation coefficients for PH, WH, WH1, WH2 and WH3.

| | PH | WH | WH1 | WH2 | WH3 |
|-----|--------|--------|--------|--------|--------|
| PH | 1.0000 | 0.9070 | 0.9112 | 0.2626 | 0.9009 |
| WH | 0.9070 | 1.0000 | 0.9723 | 0.3922 | 0.9924 |
| WH1 | 0.9112 | 0.9723 | 1.0000 | 0.3446 | 0.9541 |
| WH2 | 0.2626 | 0.3922 | 0.3446 | 1.0000 | 0.3234 |
| WH3 | 0.9009 | 0.9924 | 0.9541 | 0.3234 | 1.0000 |

Table A2. Correlations coefficients in 91 countries

Source: Elaborated from table A1.

The highest correlations of PH are with WH1, the produced capital, and WH3, intangible (human) capital, while the correlation of PH with WH2 is much lower. Overall there is a 90.7% of correlation between Wealth per capita (WH) and Gross Domestic Product per capita (PH). There is also a high correlation coefficient of WH1 with WH3, of 95.41%, due the to positive impact of Human Capital per capita on Physical Capital per capita, as seen in Guisan and Neira(2016) and other studies.

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