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Serbian Journal of Management 12 (2) (2017) 255 - 270

Serbian Journal of Management

MEASURING OF HUMAN DEVELOPMENT THROUGH THE OUTPUT-ORIENTED SUPER EFFICIENCY VRS DEA MODEL WITHOUT INPUTS

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(Received 20 June 2017; accepted 02 August 2017)

Abstract

The Human Development Index (abbv. HDI) being a popular measure of human well-being has become a measure of human development. However, the HDI has received the major criticisms relating the data structure and the particularly equal weighting scheme. In this study, to eliminate mentioned shortcomings, the measurement of human development was again revisited in the light of data envelopment analysis (DEA). All of the variables used in HDI account were taken as output variables to sort out the relative performance of the countries. In the absence of input variables, and a case in which there are only output variables was reorganized by the formulation of super-efficiency model developed by Andersen and Petersen (1993). The formulation obtained was applied to the Radial based DEA model without inputs, which it is considered as the output of all of the relevant variables, and developed by Lovell and Pastor (1999).

Keywords: Human Development Index; Data Envelopment Analysis; Efficiency

1. INTRODUCTION

1.1. The Definition and History of Human Development Index (HDI)

Economists have addressed regarding per capita income to questions such as how has world wellbeing evolved over the long run? How can regions be compared to each other? Have their differences widened (Prados de la Escosura, 2015)? Human wellbeing is widely viewed, however, as a multidimensional phenomenon, in which income is only one facet. For this reason, new approaches appeared after 1970's which aim to define development expressing

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DOI: 10.5937/sjm12-11184

human prosperity with its social, cultural, environmental and spatial dimensions (DPT, 2007). As a result of, non-income dimensions of well-being such as infant mortality, life expectancy at birth, height literacy, etc. have been used individually or combined into a composite index (physical quality of life, basic needs, and more recently human development) to provide welfare measures that go beyond gross domestic product (GDP). This composite index obtained was called as Human Development Index (HDI).

HDI being a popular measure of human well-being is annually reported by the United Nations Development Program (UNDP). In this report, life expectancy, education, and GDP indexes are created based on factors such as a long and healthy life, social and political independence, human rights. As a result of, HDI index information such as the fact whether the relevant country is a developed, developing or underdeveloped country, and also to what extent its economy affects the life quality is presented.

HDI was initially developed in 1990 by Mahbubul Haq, a Pakistani economist and has been submitted in annual development report by United Nations Development program since 1993 (Prados de la Escosura, 2015). The three core dimensions of the HDI were life expectancy (LE), schooling (S) and income (Y). According to the 20th human development report published in 2010, there have been some changes in the HDI measurement. According to last calculation, life expectancy is the only core dimension that is unchanged in the 2010 HDI. Gross national income (GNI) has replaced GDP calculated according to purchasing power parity (PPP). Literacy and the gross enrollment rate (as used in the former HDI) have been replaced by mean years of schooling (MS) and the expected years of schooling (ES), given by the years of schooling that a child can expect to receive given current enrolment rates (Ravallion, 2012).

As in the past, the three core dimensions of the HDI are first put on a standard (0, 1) scale. The rescaled indicators are:

$$I_x = \frac{x - x^{\min}}{x^{\max} - x^{\min}}, \quad (x = LE, S) \tag{1}$$

$$I_Y = \frac{\ln Y - \ln Y^{\min}}{\ln Y^{\max} - \ln Y^{\min}} \tag{2}$$

It is assumed that $x_{\min} \le x_i \le x_{\max}$ (x=LE, S, Y) for all i. Where I_s is itself a composite index of Mean Years of Schooling (MS) and Expected Years of Schooling (ES). From here, I_s index of the new HDI has calculated as:

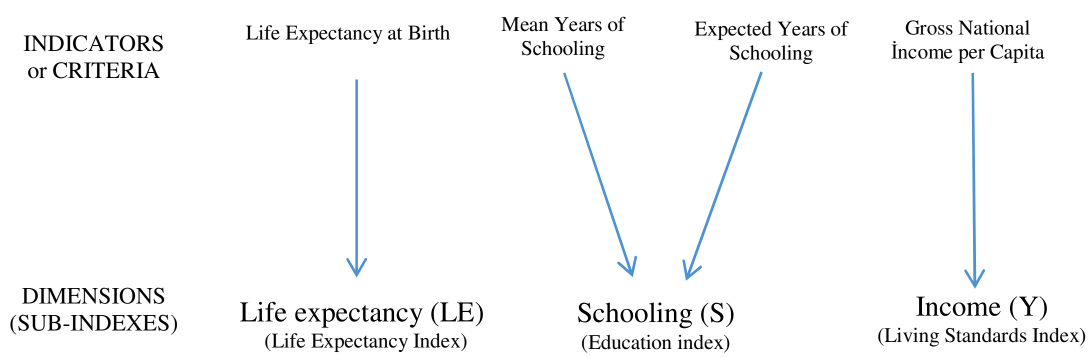

Figure 1. The HDI dimensions and indicators - Source: UNDP, Human Development Report, 2010.

$$I_S = (MS / MS^{\max})^{0.5} (ES / ES^{\max})^{0.5} \quad (3)$$

For the 2010 HDI, life expectancy is bounded below by 20 years, and above by 83.2 years (Japan's life expectancy). GNI per capita is bounded below by \$163 (the lowest value, for Zimbabwe in 2008) and above by \$108,211 (for the United Arab Emirates in 1980). The new education variables are both taken to have lower bounds of zero with MS bounded above by 13.2 years (the US in 2000), and ES bounded above by 20.6 years (Australia, 2002) (Ravallion, 2012).

An important change is about how the three scaled indicators are aggregated. While the former HDI used arithmetic means (that is $HDI_{old} = (I_{LE} + I_S + I_Y)/3$) of variables, 2010 HDI used their geometric means:

$$HDI_{new} = I_{LE}^{1/3} . I_S^{1/3} . I_Y^{1/3} \quad (4)$$

As a result, countries are classified as very high human development, high human development, medium human development, and low human development.

1.2. Literature Review

Among the indexes aiming to measure human development, HDI had been one of the most prevalently used indicators for prosperity comparisons in its 20 years of history due to its transparency and simplicity as well as multi-dimensional prosperity measurement (Harttgen & Klasen, 2012). However, HDI received serious criticisms varying from its creation and composition to its expansion and containing more dimensions.

Critiques regarding HDI can be investigated in three broad categories. Accordingly, the first group of critiques relates to dimensions and indicators of the HDI. Ogwang (1994) found that life expectancy would be the best choice to represent the three components of the HDI, and thus suggested one variable selection strategy. Accordingly, it was determined that a simplified HDI could be obtained, without loss of too much information and at a lower cost, by subtracting the life expectancy deprivation index from unity. Engineer et al. (2008) argued that it is better to drop the income component from the HDI because it does not play its expected role of accessing a decent standard of living.

Bhanojirao (1991) suggested the inclusion of additional dimensions such as political, economic and social freedom, opportunities for being creative and productive, personal self-respect, and guaranteed human rights. Ranis et al. (2005) stressed the need of neglecting some relevant dimensions and identified new categories encompassing all the major dimensions of human development. Sanusi (2008) implied that housing facilities and housing conditions increased the scope of human development, and thereby tried to widen the scope of issues covered by the HDI.

Dias et al. (2006), Moran et al. (2008), Morse (2003) and Neumayer (2001) were concerned about consideration of natural resources conservation, environment, and national energy uses concepts in development measuring.

The second group of critiques is based that the HDI do not take into account inequality within countries. According to this opinion, the HDI looks at the average achievements and does not reflect the distribution of human development within a country. Some adjustments to variables such as gender, ethnic and income groups have been suggested To eliminate the concept of inequality.

The UNDP offered the Gender-Related Development Index (GDI) in the direction of this second group of critiques. The GDI adjusts the HDI by eliminating gender inequalities in life expectancy, education, and income dimensions by measuring each indicator separately for men and women, and then calculating the harmonic mean of them (UNDP, 1995).

About income inequality, Hicks (1997) suggested an Inequality-Adjusted Human Development Index (IHDI) together with the HDI by proposing to discount each dimensional index by one minus of the Gini coefficient before the mean of the indexes of life, education and income are taken. Afterward, Sagar and Najam (1998) pointed out that the use of the GDP per capita component as a proxy for average income would not allow for major differences in income distribution within a country.

Harttgen and Klasen (2012) proposed a method to calculate a proxy HDI at the household level to allow the analysis of the inequality in human development among population subgroups according to socio-economic characteristics.

The third group of critiques is related to HDI analytical framework and methodology. Firstly regarding methodological framework, an arbitrary equally weighting of the education, life and income indexes of the HDI was criticized (Kelley, 1991; Ravallion, 1997; Srinivasan, 1994). Afterward, resulting in a modified version of HDI index, it was suggested some modifications in two categories of technical issues ranging from those related to the components of the index to those relevant to the structure of the index (Noorbakhsh, 1998).

Wolff et al. (2011) calculated the likelihood of each country's deviation from the original published HDI rank. Also, they mentioned from the data errors such as the measurement error due to data updating, the data noise due to formula revision and the misclassification due to inconsistent thresholds of classifying a country's development status.

There are also some the different methodological approaches which are used to calculate the rank of countries. The framework providing a fuzzy representation of the HDI and its three components (Baliamoune-Lutz & McGillivray, 2006), the Multiple Criteria Decision Making (MCDM) technique (Safari & Ebrahimi, 2014) and DEA-like linear programming model that are developed to assess the relative performance of the countries in terms of human development (Despotis, 2005) are some of these ranking methodologies.

It is more important to determine an appropriate measurement method rather than a selection of the indicator variables and consideration inequality within countries to measure human development. Since, as it appears from the literature, made with an arbitrary equally weighting of the variables used in the HDI calculation and being a simple index based on a geometric mean is a situation that has been criticized. If this fundamental problem for the measurement of human development is exceeded, then it can be re-ranking of countries by considering the different indicator variables. However, the various methodologies as MCDM which are used to calculate the rank of countries may reveal different rankings. So, in this study, the Data Envelopment Analysis (DEA) which is a linear programming model was used to rank countries according to their level of development.

Because of the multidimensional nature of human development, it is hard to measure and analyze HDI. Since DEA analysis provides a significant contribution to the better understanding and study of this process, it has been commonly used in the literature. A literature review paper towards the utilization of the DEA conducted for the measurement of human development is made by Mariano et al. (2015).

2. METHODOLOGY

2.1. Data Envelopment Method

The idea of measuring and analyzing human development is a difficult situation, due to its multi-dimensional nature. Therefore, DEA can significantly contribute to this process by making it possible to study better and understand.

DEA is a methodology that allows relative evaluation of the performance of a set of the comparable entities called Decision Making Units (DMUs) which convert multiple inputs into multiple outputs (Cooper et al., 2011). The DEA approach that determines the set of weights by optimizing the efficiencies of decision units for a mathematical model combining in a unity score of multiple input and output without requiring a common unit of measure is a mathematical procedure based on linear programming (Cooper et al., 2007). Moreover, it identifies an efficient frontier where all DMUs have a unity score. If there are DMUs which are on this efficient frontier, then, these DMUs are referred to as efficient decision units (Ebadi, 2012). Initially, CRS Constant Returns to Scale (CRS) model was introduced in 1978 by Charnes, Cooper and Rhodes. Variable Returns to Scale (VRS) model was introduced by Banker, Charnes and Cooper in 1984. Following years, differentiations occurred together with the models such as the Additive Model, A Slacks-Based Measure of Efficiency (SBM).

Many DEA models can be established according to application areas and assumptions. These models can be separated into two main groups as input or output oriented. The one's input oriented examine to what extent they should decrease the inputs of decision units which are not effective at any output level. Similarly, effectiveness measures aiming at output focus on to what extent they can increase their outputs so as to efficient the inefficient decision units for any input composition. Accordingly, it is stated that "Input oriented models decrease input usage proportionally at constant output level so as to measure technical ineffectiveness." If the models can not be configured as input or output oriented, integrated models can be used. The two scale values are observed to give same value at CRS, and it is little different in comparison with VRS. In the majority of studies in literature, as input amount appears to be primary decision variable, input-oriented models were frequently selected. However, there can be some cases in which source quantity is kept constant, and output quantity is increased as much as possible. In the last case, output focused model is more suitable (Coelli & Perelman, 2000). Accordingly, the mathematical expressions of CRS and VRS models are presented in Table 1.

According to Table 1, X is the matrix providing the inputs for all decision units in n×m dimension and Y is the matrix providing the outputs of all decision units in n×s dimension. Accordingly, the vectors with a m×1 and s×1 dimension which respectively provide the inputs and outputs of that decision unit are input and output weighted vectors. Again θ_0 and $\emptyset_0$ which are a scalar

Table 1. Mathematical Expressions of the Models of the Constant Return to Scale and Variable Return to Scale

	Primal	Dual
Input oriented	$mak \quad z_o = \sum_{r=1}^{s} u_i y_{io} - (u_o)^*$ **Subjects to:** $\sum_{i=1}^{m} v_i x_{io} = 1$ $-\sum_{i=1}^{m} v_i x_{ij} + \sum_{r=1}^{s} u_r y_{rj} - (u_o)^* \leq 0$ $v_i \geq 0 \quad u_r \geq 0 \quad u_o$ **Infinite**	$\min \quad \theta_o$ **Subjects to:** $\sum_{j=1}^{n} \lambda_j x_{ij} - \theta_o x_{io} \leq 0 \quad i = 1,\ldots,m$ $y_{ro} - \sum_{r=1}^{s} \lambda_j y_{ij} \leq 0 \quad r = 1,\ldots,s$ $\left(\sum_{j=1}^{n} \lambda_j = 1\right)^*$
Output oriented	$\min \quad z_o = \sum_{i=1}^{m} v_i x_{io} - (v_o)^*$ **Subjects to:** $\sum_{r=1}^{s} u_r y_{ij} = 1$ $\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} - (v_o)^* \leq 0$ $v_i \geq 0 \quad u_r \geq 0 \quad v_o$ **Infinite**	$mak \quad \phi_o$ **Subjects to:** $\sum_{j=1}^{n} \lambda_j x_{ij} - x_{io} \leq 0 \quad i = 1,\ldots,m$ $\phi_o y_{ro} - \sum_{r=1}^{s} \lambda_j y_{ir} \leq 0 \quad r = 1,\ldots,s$ $\left(\sum_{j=1}^{n} \lambda_j = 1\right)^*$

(*) it is added as a constraint for VRS model

units are the effectiveness score of the decision unit. Under these assumed limitations, the model is solved separately for *n* decision units, and score values of each decision unit are obtained. As primal linear model's number of limitations is higher compared to the dual one, the dual model is preferred regarding ease of operation.

2.2. DEA Models without Inputs

Sometimes, for each DMU, there may be a condition which there are only the output variables in the absence of input variables of them. For example, all of the variables (namely, variables such as life expectancy at birth, mean years of schooling, expected years of schooling, gross national income per capita used to create the HDI) used for ranking of the countries efficiency values are output in the DEA analysis in this study. If a composite index (CI) that will be created by using DEA has only the desirable attributes in this way, then the approach utilized will be called as "the benefit of the doubt (BoD)" (Mariano et al., 2015). While the standard DEA models are based on the ratio between desirable (more-the-better) and undesirable (less-the-better) performance measures, BoD models use only the desirable attributes and are exclusively focused on aggregating outputs. In this regard, BoD differs from the standard DEA-models (De Witte et al., 2013).

The radial based DEA without inputs models developed by Lovell and Pastor (1999) suggested that efficiency measurements will be performed through output variables for a case in which there are no input variables.

Lovell and Pastor (1999) have proven the below properties for models mentioned above:

I) Without input (or without output) CRS models can not distinguish efficient and inefficient units.

II) Output oriented CRS models with single constant input, and input-oriented CRS models with single constant output collide with related VRS models.

III) Output oriented VRS models with constant input (or input oriented with single constant output) are equivalent to VRS models without input (or without output).

IV) All VRS models without input (or without output) can be summarized with models having single incomplete variable and single incomplete constraint.

In an output focused model, aim function maximizes the output and provide income level. This model seeks to produce maximum output with current input. The situation where source amount is constant and accordingly increasing output amount as much as possible is desired by country governing people, and also it is easier to control. For this reason, it was stated by Lovell and Pastor (1999) that output oriented VRS model is suitable to make an evaluation by taking advantage of radial based DEA models without input. As a matter of fact, this corresponds to output oriented VRS model having single constant input. In fact, according to (II) item, output oriented CRS model having single constant input collides with VRS model. Namely, both of them express the same thing. Accordingly, the mathematical expressions of primal and dual of output focused DEA models without input are presented in Table 2.

This BoD approach put forwarded by Lovell and Pastor (1999) was firstly used to recalculate HDI by Mahlberg and Obersteiner (2001). Afterward, the advances in the BoD approach were presented by De Witte et al. (2013) and Färe and Karagiannis (2014). However, it is observed that none of these studies consists of eliminating from the linear programming model the restriction that limits to one the efficiency of the unit being analyzed. If the restriction that limits to one the efficiency of the unit being analyzed is eliminated from the linear programming model, then, this construction

Table 2. The output-oriented VRS model without inputs

	Primal	**Dual**
The output-oriented VRS model without inputs	$\min \quad z_o = -v_o$ **Subjects to:** $\sum_{r=1}^{s} u_r y_{ro} = 1$ $\sum_{r=1}^{s} u_r y_{rj} + v_o \leq 0, \quad and \quad j = 1,...,n$ $v_i \geq 0 \quad u_r \geq 0 \quad v_o$ **Infinite**	mak ϕ_o **Subjects to:** $\phi_o y_{ro} - \sum_{r=1}^{s} \lambda_j y_{ir} \leq 0 \quad r = 1,\ldots,s$ $\left(\sum_{j=1}^{n} \lambda_j = 1 \right)^*$

is called as super efficiency model. According to this, when BoD approach is applied on super efficiency model, the sequencing of DMUs will again be provided according to a composite index (CI).

2.3. A Super Efficiency Model without Inputs for Ranking Units in DEA

According to the optimal solution of the output-oriented radial DEA model without inputs shown in Table 2. If a DMU achieves the maximum possible value of 100%, it is efficient. Otherwise, it is inefficient, and the ratio values of which are inefficient are above one (Poveda, 2011). However, it may sometimes be necessary to rank the performance of efficient DMUs. For such a situation, super efficiency model has been proposed by (Andersen & Petersen, 1993).

Super efficiency DEA models also called as AP models can be used in ranking the performance of efficient DMUs. In fact, when a DMU under evaluation is not included in the reference set of the original DEA models, the resulting DEA models are called super-efficiency DEA models. Additionally, the super-efficiency DEA model can be obtained as either situation CRS or VRS (Ebadi, 2012).

For the aim of ranking countries according to the variables used in the HDI calculation, if the formulation of super-efficiency model developed by Andersen and Petersen (1993) is applied to the Radial based DEA model without inputs, which it is considered as the output of all of the relevant variables, developed by Lovell and Pastor (1999), it can be achieved the ranking of the countries called as decision-making units. Accordingly, mathematical expressions of primal and dual of output focused super affectivity DEA models without input formed for ranking DMU's are presented in Table 3.

3. MODEL, RESULTS, AND DISCUSSION

The aim of this analysis is to compare results of the traditional HDI scale and the output-oriented super-efficiency DEA model without inputs put forward by the research and to propose a new scaling to measure human development. Then, when an output-

Table 3. The output-oriented super efficiency VRS model without inputs

	Primal	Dual
The Output-Oriented Super Efficiency VRS Model Without Inputs	$\min \quad z_o = -v_o$	mak $\quad \phi_o$
	Subjects to:	**Subjects to:**
	$\sum_{r=1}^{s} u_r y_{ro} = 1$	$\phi_o y_{ro} - \sum_{\substack{j=1 \\ j \neq o}}^{n} \lambda_j y_{rj} \leq 0, \quad r = 1,\dots,s$
	$\sum_{r=1}^{s} u_r y_{rj} + v_o \leq 0, \quad j = 1,\dots,\mathrm{n} \quad \mathit{and} \quad j \neq o$	$\sum_{\substack{j=1 \\ j \neq o}}^{n} \lambda_j = 1$
	$v_i \geq 0 \quad u_r \geq 0 \quad v_o$ **Infinite**	

oriented super-efficiency DEA model without inputs with the output variables (life expectancy at birth- LE, mean years of schooling- MS, expected years of schooling- ES, gross national income (GNI) per capita- GNIpc) used in the calculation of HDI index is created in order to evaluate the relative performance of 187 countries being the comparable entities, this model is equivalent to VRS DEA model with four outputs. Let ø be the optimal value of the objective function when the model is solved for country j. So, dual of the proposed model is:

Dual model:

max ϕ_o

Subjects to:

$$\phi_o.LE_o - \sum_{\substack{j=1 \\ j\neq o}}^{187} \lambda_j.LE_j \leq 0 \tag{5}$$

$$\phi_o.\mathrm{MS}_o - \sum_{\substack{j=1 \\ j\neq o}}^{187} \lambda_j.MS_j \leq 0 \tag{6}$$

$$\phi_o.ES_o - \sum_{\substack{j=1 \\ j\neq o}}^{187} \lambda_j.ES_j \leq 0 \tag{7}$$

$$\phi_o.GNIpc_o - \sum_{\substack{j=1 \\ j\neq o}}^{187} \lambda_j.GNIpc_j \leq 0 \tag{8}$$

$$\sum_{\substack{j=1 \\ j\neq o}}^{n} \lambda_j = 1 \tag{9}$$

$$\lambda_j \geq 0 \tag{10}$$

In those above dual mathematical model, it is written a constraint corresponding to each output variable. However, if the primal of the model were constructed, a constraint for each country would be written, which would cause the model to expand too much and extend the solution period. If so, efficiency scores obtained from countries together with the solution of presented optimization model as follows:

When "The Output-Oriented Super Efficiency VRS DEA Model without Inputs" established is solved for each country, the results obtained are given in Table 4-Table 7.

HDI index is calculated according to values of LE, MS, ES and GINI variables. According to the findings, the countries demonstrating a high degree of deviation in suggested DEA efficiency score ranking together with HDI index rating were observed to be originated from the fact that they have too high or too low values regarding values of variables according to HDI calculation used compared with other nearby countries. According to results presented in Table 4- Table 7.

When obtained findings are evaluated, it is understood that the relative value in any of the output variables of the application is subject to a ranking originated from the fact that it is too high or too low compared with the others. The application determines the efficiency score of the country according to the variable demonstrating high degree of deviation from the value average of countries incorporated into the model and forms the effective ranking accordingly. This fact shows that the variables which are the base for calculation while HDI index is calculated, were not used at efficient ratios and that the ranking was not realized with the real values of countries.

Table 4. Data and optimization results for the countries in a group of Very high human development according to the proposed "Output-Oriented Super Efficiency VRS DEA Model without Inputs"

New Ranking	HDI Ranking	HDI Group	Countries	Efficiency Scores
1	31	very high	Qatar	0.7316
2	2	very high	Australia	0.9545
3	1	very high	Norway	0.9643
4	5	very high	United States	0.9901
5	17	very high	Japan	0.9923
6	9	very high	Singapore	0.9934
7	6	very high	Germany	0.9951
8	15	very high	Hong Kong. China (SAR)	0.9955
9	3	very high	Switzerland	0.9963
10	13	very high	Iceland	1.008
11	18	very high	Liechtenstein	1.0093
12	19	very high	Israel	1.0098
13	26	very high	Italy	1.0111
14	27	very high	Spain	1.0123
15	8	very high	Canada	1.0153
16	12	very high	Sweden	1.0154
17	7	very high	New Zealand	1.0173
18	20	very high	France	1.0188
19	16	very high	Korea (Republic of)	1.0192
20	4	very high	Netherlands	1.0217
21	23	very high	Luxembourg	1.0243
22	11	very high	Ireland	1.0246
23	14	very high	United Kingdom	1.0259
24	21	very high	Austria	1.0269
25	37	very high	Andorra	1.0289
26	29	very high	Greece	1.0299
27	24	very high	Finland	1.0313
28	22	very high	Belgium	1.0332
29	10	very high	Denmark	1.0401
30	32	very high	Cyprus	1.0406
31	42	very high	Portugal	1.0406
32	25	very high	Slovenia	1.0409
33	35	very high	Lithuania	1.0421
34	41	very high	Chile	1.044
35	65	high	Lebanon	1.0447
36	68	high	Costa Rica	1.0457
37	30	very high	Brunei Darussalam	1.0461
38	28	very high	Czech Republic	1.0468
39	39	very high	Malta	1.048
40	45	very high	Cuba	1.0545
41	60	high	Palau	1.0625
42	80	high	Georgia	1.0692
43	103	medium	Maldives	1.0727
44	33	very high	Estonia	1.0737
45	46	very high	Kuwait	1.0759
46	94	high	Dominica	1.0761
47	66	high	Panama	1.0777
48	50	high	Uruguay	1.0779
49	40	very high	The United Arab Emirates	1.078

Table 5. Data and optimization results for the countries in a group of high human development according to the proposed "Output-Oriented Super Efficiency VRS DEA Model without Inputs"

New Ranking	HDI Ranking	HDI Group	Countries	Efficiency Scores
50	71	high	Mexico	1.0784
51	36	very high	Poland	1.080
52	95	high	Albania	1.080
53	47	very high	Croatia	1.0802
54	49	very high	Argentina	1.0875
55	44	very high	Bahrain	1.0898
56	56	high	Oman	1.0902
57	99	high	Ecuador	1.093
58	34	very high	Saudi Arabia	1.0944
59	86	high	Bosnia and Herzegovina	1.0944
60	38	very high	Slovakia	1.0956
61	90	high	Tunisia	1.0993
62	61	high	Antigua and Barbuda	1.1004
63	122	medium	Viet Nam	1.1005
64	55	high	Libya	1.102
65	57	high	Russian Federation	1.1036
66	59	high	Barbados	1.1036
67	51	high	Bahamas	1.1043
68	43	very high	Hungary	1.1084
69	69	high	Turkey	1.1085
70	91	high	China	1.1095
71	85	high	The former Yugoslav Republic of Macedonia	1.1115
72	52	high	Montenegro	1.112
73	123	medium	Cape Verde	1.113
74	62	high	Malaysia	1.1141
75	87	high	Armenia	1.1149
76	132	medium	Nicaragua	1.1168
77	82	high	Peru	1.117
78	97	high	Saint Lucia	1.1173
79	67	high	Venezuela (Bolivarian Republic of)	1.1181
80	74	high	Sri Lanka	1.1184
81	53	high	Belarus	1.1198
82	119	medium	The Syrian Arab Republic	1.1211
83	75	high	Iran (The Islamic Republic of)	1.1231
84	89	high	Thailand	1.1234
85	48	very high	Latvia	1.1239
86	79	high	Brazil	1.1247
87	54	high	Romania	1.1259
88	63	high	Mauritius	1.128
89	78	high	Serbia	1.1284
90	98	high	Colombia	1.1289
91	84	high	Belize	1.1307
92	58	high	Bulgaria	1.1312
93	77	high	Jordan	1.1317
94	129	medium	Honduras	1.1323
95	73	high	Saint Kitts and Nevis	1.1361
96	96	high	Jamaica	1.1368
97	102	high	Dominican Republic	1.1387
98	106	medium	Samoa	1.1394
99	81	high	Grenada	1.1398
100	107	medium	Palestine. State of	1.1418
101	72	high	Seychelles	1.142
102	83	high	Ukraine	1.1442

Table 6. Data and optimization results for the countries in a group of medium human development according to the proposed "Output-Oriented Super Efficiency VRS DEA Model without Inputs"

New Ranking	HDI Ranking	HDI Group	Countries	Efficiency Scores
103	101	high	Tonga	1.1451
104	115	medium	El Salvador	1.1513
105	92	high	Saint Vincent and the Grenadines	1.1529
106	76	high	Azerbaijan	1.1535
107	111	medium	Paraguay	1.1567
108	125	medium	Guatemala	1.1592
109	137	medium	Cambodia	1.1622
110	131	medium	Vanuatu	1.1669
111	93	high	Algeria	1.1734
112	110	medium	Egypt	1.1746
113	100	high	Suriname	1.1769
114	130	medium	Morocco	1.1782
115	108	medium	Indonesia	1.18
116	64	high	Trinidad and Tobago	1.1818
117	142	medium	Bangladesh	1.1829
118	88	high	Fiji	1.186
119	120	medium	Iraq	1.204
120	114	medium	Moldova (Republic of)	1.2092
121	124	medium	Micronesia (The Federated States of)	1.2114
122	133	medium	Kiribati	1.213
123	117	medium	Philippines	1.2165
124	116	medium	Uzbekistan	1.2172
125	145	low	Nepal	1.2218
126	139	medium	Lao People's Democratic Republic	1.2236
127	136	medium	Bhutan	1.2238
128	104	medium	Mongolia	1.2273
129	134	medium	Tajikistan	1.2346
130	158	low	Solomon Islands	1.235
131	70	high	Kazakhstan	1.2362
132	126	medium	Kyrgyzstan	1.237
133	128	medium	Timor-Leste	1.2375
134	113	medium	Bolivia (Plurinational State of)	1.2389
135	146	low	Pakistan	1.2555
136	135	medium	India	1.2585
137	143	medium	Sao Tome and Principe	1.2599
138	121	medium	Guyana	1.2607
139	105	medium	Turkmenistan	1.2643
140	150	low	Myanmar	1.2824
141	155	low	Madagascar	1.2913
142	127	medium	Namibia	1.2962
143	151	low	Rwanda	1.2979
144	109	medium	Botswana	1.2981

Table 7. Data and optimization results for the countries in a group of lower human development according to the proposed "Output-Oriented Super Efficiency VRS DEA Model without Inputs"

New Ranking	HDI Ranking	HDI Group	Countries	Efficiency Scores
145	118	medium	South Africa	1.2994
146	173	low	Ethiopia	1.3134
147	112	medium	Gabon	1.3135
148	163	low	Senegal	1.3172
149	154	low	Yemen	1.3243
150	168	low	Haiti	1.3245
151	182	low	Eritrea	1.3298
152	157	low	Papua New Guinea	1.339
153	166	low	Sudan	1.3469
154	170	low	Djibouti	1.3524
155	147	low	Kenya	1.3543
156	161	low	Mauritania	1.3579
157	160	low	Tanzania (The United Republic of)	1.3584
158	159	low	Comoros	1.3646
159	138	medium	Ghana	1.3656
160	169	low	Afghanistan	1.3714
161	175	low	Liberia	1.3802
162	156	low	Zimbabwe	1.396
163	165	low	Benin	1.408
164	164	low	Uganda	1.4116
165	140	medium	Congo	1.4198
166	172	low	Gambia	1.421
167	141	medium	Zambia	1.4226
168	187	low	Niger	1.4309
169	167	low	Togo	1.4675
170	181	low	Burkina Faso	1.4834
171	179	low	Guinea	1.4895
172	174	low	Malawi	1.5069
173	152	low	Cameroon	1.5159
174	176	low	Mali	1.5188
175	177	low	Guinea-Bissau	1.5395
176	180	low	Burundi	1.5435
177	144	medium	Equatorial Guinea	1.5751
178	153	low	Nigeria	1.5918
179	149	low	Angola	1.5972
180	184	low	Chad	1.633
181	171	low	Côte d'Ivoire	1.6478
182	178	low	Mozambique	1.661
183	185	low	The Central African Republic	1.6656
184	186	low	Congo (The Democratic Republic of the)	1.6687
185	162	low	Lesotho	1.6747
186	148	low	Swaziland	1.6876
187	183	low	Sierra Leone	1.8345

4. CONCLUSIONS

Although there are different opinions related to dimensions and indicators regarding the measure of human development, the main opinion is related to its calculation method. If the calculation method is correctly determined, then the dimensions and indicators by appropriate analytical framework and methodology can be constructed. So, the HDI being a popular measure of human well-being has become a measure of human development. HDI was being computed by the average of the four HDI indicators until 2010. Then countries were ranked according to this overall index. In the 2010 and 2011 HDRs, UNDP changed its method of computing the HDI from simple average to geometric average. However, this new method is still being faced some criticisms. The first group of critiques relates to the fact that three component indices of HDI are taken into consideration as equal weights. The second group of critiques relates to normalization technique of variables used in the calculation of the index. Because as a result of normalization, the main structure of the data changes. If so, the relative position of the countries in the HDI ranking can be attributed to two main reasons: One is structural and is related to the data themselves, the other is linked with the particular weighting scheme (equal weights) used in the HDI. In this study, considering these shortcomings, the measurement of human development has been again revisited in the light of DEA. DEA analysis is an appropriate tool for the measurement and analysis of issues related to human development by evaluating the efficiency in generating quality of life from wealth or economic, social and environmental resources. All of the variables LE, MS, ES, GNIpc used in HDI account were taken as output variables to measure the performance of the countries by the DEA analysis in this study. The Radial based DEA model without inputs developed by Lovell and Pastor (1999) was used for a case which an efficiency measurement through output variables in the absence of input variables was performed. In order to rank the performance of efficient DMUs (herein, the countries) according to the optimal solution of the output-oriented radial DEA model without inputs, the formulation of super-efficiency model developed by Andersen and Petersen (1993) was applied to the Radial based DEA model without inputs, which it is considered as the output of all of the relevant variables, and developed by Lovell and Pastor (1999). Hence, the ranking of the countries was provided. As a result of the findings, a new scaling named the output-oriented super-efficiency DEA model without inputs put forward by this study as an alternative to the traditional HDI scale to measure human development was proposed. The problems relating to the data structure and the particular weighting scheme (equal weights), which are encountered in HDI calculations, were tried to be eliminated by the proposed method.

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ПРОЦЕНА ИНДЕКСА ЉУДСКОГ РАЗВОЈА УПОРЕЂЕЊЕМ МОДЕЛА СУПЕР ЕФИКАСНОСТИ ОРИЈЕНТИСАНЕ НА ОДЗИВЕ НАСУПРОТ ДЕА МОДЕЛА БЕЗ УЛАЗНИХ ПРОМЕЊИВИХ

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Извод

Индекс људског развоја (ХДИ) који је популарна мера добробити човечанства, постао је мера развоја људске заједнице. Ипак, ХДИ добија и значајне критике које се односе на структуру података и посебно одређивања тежинских коефицијената. У овој студији, извршено је мерење људског развоја и кроз методологију анализе садржајности података (ДЕА), у циљу елиминације недостарака ХДИ методе. Све промењиве које се узимају при ХДИ анализи су узете као излазне промењиве како би се упоредиле релативне перформансе међу државама. У недостатку улазних промењивих, и у случају где су само излазне варијабле на располагању, извршено је реорганизовање формулисањем модела супер - ефикасности који су развили Andersen и Petersen (1993). Добијена формулација је примењена на ДЕА модел радијалне основе, без улазних величина, који се сматра излазом свих релевантних варијабли , према истраживању Lovell и Pastor-a (1999).

Кључне речи: Индекс људског развоја, анализа обухвата података; ефикасност

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