RECOMPUTATION OF UNDP'S HDI RANKINGS BY DATA ENVELOPMENT ANALYSIS

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Abstract

The HDI has played an influential role in the debate on human development. No index is perfect and so is the Human Development Index of United Nations Development Program. This paper aims to measure the performance of 182 countries in terms of performance by means of non-parametric input oriented CRS employed Data Envelopment Analysis. In addition, it elaborates on the cut-off values assigned by UNDP to categorize the countries. By means of this research, countries will be able to choose those elements by benchmarking from other countries that are applicable and most likely to develop strategy formulation processes for human development and international growth.

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I. Introduction

Today, normalised measures of life expectancy, literacy, educational attainment, and GDP per capita are considered to be the main indicators of development for countries worldwide. These three indicators are unified to give a measure of development, namely the Human Development Index (HDI). HDI has been first used in the United Nations Development Program's (UNDP) World Development Report. Since the first publication of this annual report in 1990, UNDP has been seeking to explore the concept and measurement of global human development.

The Human Development Index (HDI) computes and assigns a single, scalar value to each country of the world based on three components of human development. This simple measure has changed the global debate on development and influenced public policy around the world. Criticism and proposed alternatives abound, yet the index has managed to maintain its popularity and simplicity with only minor modifications over the years of 1991, 1994, 1995, 1999 and 2005. The HDI was developed to measure "the basic concept of human development to enlarge people's choices" (Ul Haq, 1995). It was also designed as an alternative to the use of GDP per capita alone as a measure of human development. To these ends, it must be concluded that the HDI has achieved overwhelming success. However, it is still prone to criticisms as it lacks the means to correctly measure and analyse the annual performance of countries.

Ul Haq stated that the purpose of the HDI was to measure at least a few more choices besides income and to reflect them in a methodologically sound composite index. Indeed, the HDI has included only a limited number of indicators to keep it simple and manageable. This simple HDI algorithm is still being used today and calculated from regularly available data to produce a meaningful number that can be used to compare and rank countries across the world.

Up-to-date, critics on HDI have claimed that it uses very few or the wrong indicators. Others allege that it presents an oversimplified view of human development and added that a pure economic model focusing on growth alone should set the tone on discourse regarding human development. In fact, some of these critics have developed their own novel indices or have resulted in the modification of HDI. But, collecting reliable data continues to be the major obstacle in the poorest countries (Harkness, 2004). Regarding health and longevity, Harkness notes that mortality data are most likely to be missing in countries where mortality is the highest. According to another critic, both the resources allocated throughout a country and the levels of inequality that may exist across the country are not taken into account in the HDI index (Foster, 2005; Ul Haq, 1995). In recent years, most critics have taken issue with the equal weights assigned to each of the respective indicators of the index (Mahlberg and Obersteiner, 2001; Chowdhury and Squire, 2006) but assigning differing weights have been proven to be unnecessary (Stapleton and Garrod, 2007). And yet, the HDI has been extensively criticised for its lack of desirable statistical properties.

To overcome the deficiencies of previous traditional parametric approaches and weighing problems, Data Envelopment Analysis can be employed. To measure the HDI, this analysis has

been firstly used by Mahlberg and Obersteiner in 2001. The following year, Lozano and Gutierrez proposed a new DEA model that computes a range-djusted measure (RAM) of efficiency for HDI and Lee et al. (2006) made use of a fuzzy multiple objective DEA for the HDI. In 2005, the HDI of the Asian and Pacific countries were calculated by Despotis (2005). Having automatically overcome the subjectivity difficulties in weighing the component indices, this technique analyses the inherencies of the data by a different approach.

II. METHOD

Data Envelopment Analysis (DEA) is a data-oriented technique which has been proven to be an effective tool in evaluating relative efficiency. It is a nonparametric method of measuring the efficiency of a decisionmaking unit (DMU) such as a country, first introduced into Operations Research literature by Charnes, Cooper and Rhodes in 1978. Recent years have seen a great variety of applications of DEA for use in evaluating the performances of many different kinds of entities engaged in many different activities in many different contexts in many different countries such as sports, logistics, hospitals, universities, cities, business firms etc. Because it requires very few assumptions, DEA has opened up possibilities for use in cases which have been resistant to other approaches because of the complex and often unknown nature of relations between the multiple inputs and multiple outputs involved in the DMUs.

Throughout the paper, we use decision making units (DMUs) to represent countries. Each DMU is assumed to have a constant input and represented by three outputs , i.e. HDI component indicators (life expectancy index (LEI), education index (EI) and GDP per capita index (GDPI)). The DEA model used assumes an input oriented radial CRS technology.

The main advantages of DEA are: (1) Multiple inputs and outputs can be used effectively, while ascertaining efficiency, and a specific production function is not required; (2) The decision maker does not need prior information about weights of inputs and outputs; and (3) For each DMU, efficiency is compared to that of an ideal operating unit, rather than to the average performance.

The HDI is based on three indicators: longevity, as measured by life expectancy at birth; educational attainment, as measured by a combination of adult literacy (two-thirds weight) and combined primary, secondary and tertiary enrollement ratios; and standard of living, as measured by real GDPI (Purchasing Power Parity in US$). To calculate the dimension indices, UNDP has assigned minimum and maximum values (goalposts) for each underlying indicators. Performance in each dimension is then calculated and expressed as a value between 0% and 100%. Then, the HDI is calculated as a simple average of the dimension indices by basic algebra. In UNDP's approach, this was followed by assigning (equal) weights to each dimension index given as follows:

HDI = x. (LEI) + y. (EI) + z. (GDPI) (where x = y = z = 1/3).

Whereas, in our approach, the indices are analyzed by the use of linear programming methods to construct a non-parametric piece-wise surface over the data. The CRS surface is presented by a straight line that starts at the origin and passes through the first DMU that it meets as it approaches the observed population. The models with CRS envelopment surface assume that an increase in inputs will result in a proportional increase in outputs. Efficiency measures are then calculated relative to this surface. For the purpose of analyzing the data, Efficiency Measurement System (EMS) is used. The inherent weights for the inputs and outputs are assigned by the model itself.

The essence of the CRS model is the ratio of maximization of the ratio of weighted multiple outputs to weighted multiple inputs. Any country compared to others shold have an efficiency score of 100% or less. The efficiency score in the presence of multiple input and output indicators is defined as: Efficiency = Weighted sum of outputs / Weighted sum of inputs Assuming that there are n DMUs, each of with i inputs and j outputs, the relative efficiency score of a test DMU m is obtained by solving the following model proposed by [Charnes et. al., 1978]:

$$Max \frac{\sum_{j=1}^{J} v_{mj} y_{mj}}{\sum_{i=1}^{I} u_{mi} x_{mi}}$$

$$0 \le \frac{\sum_{j=1}^{J} v_{mj} y_{nj}}{\sum_{i=1}^{I} u_{mi} x_{ni}} \le 1; n = 1,2,\ldots,N$$

$$v_{mj}, u_{mi} \ge 0; i = 1,2,\ldots,I; j = 1,2,\ldots,J$$

y_{mj} = amount of output j produced by DMU m.
v_{mj} = weight given to output j

x_{mi} = amount of input i utilised by DMU m.
u_{mi} = weight given to input i

The above model is run n times in identifying the relative efficiency scores of all DMUs. Each DMU selects input and output weights that maximize its efficiency score. In general, a DMU is considered to be efficient if it obtains an efficiency score of 100% and a score of less than 100% implies that it is inefficient.

III. ANALYSIS

Unlike the HDI, the DEA scores on Table 1 are relative measures. Each country is compared with the best practice countries when it assesses its composite performance on the human development indicators. As shown in Table 1, the EMS analysis has yielded differences in country rankings between the UNDP and DEA approaches. The DEA approach identified a group of 20 optimally performing countries that are defined as efficient and assigns them an efficiency score of 100%. These efficient countries are then used to create an "efficiency frontier" or "data envelope" against which all other countries are compared. In sum, countries that require relatively more weighted inputs to produce weighted outputs, or, alternatively, produce less weighted output per weighted inputs than do countries on the efficient frontier, are considered technically inefficient. They are given efficiency scores of less than 100%, but greater than 0%.

Table 1 HDR 2009 Data and DEA Rankings

UNDP ranking	DMU	HDI	Efficiency Score	GDP per capita index	Education Index	Life Expectancy Index	DEA ranking
1	Norway	0,971	100,00%	1,000	0,989	0,925	1
2	Australia	0,970	100,00%	0,977	0,993	0,940	1
3	Iceland	0,969	100,00%	0,981	0,980	0,946	1
4	Canada	0,966	99,85%	0,982	0,991	0,927	21
5	Ireland	0,965	100,00%	1,000	0,985	0,911	1
6	Netherlands	0,964	99,59%	0,994	0,985	0,914	22
7	Sweden	0,963	99,41%	0,986	0,974	0,930	24
8	France	0,961	99,09%	0,971	0,978	0,933	25
9	Switzerland	0,960	100,00%	1,000	0,936	0,945	1
10	Japan	0,960	100,00%	0,971	0,949	0,961	1
11	Luxembourg	0,960	100,00%	1,000	0,975	0,906	1
12	Finland	0,959	100,00%	0,975	0,993	0,908	1
13	United States	0,956	100,00%	1,000	0,968	0,902	1
14	Austria	0,955	98,86%	0,989	0,962	0,915	26
15	Spain	0,955	98,59%	0,960	0,975	0,929	29
16	Denmark	0,955	100,00%	0,983	0,993	0,887	1
17	Belgium	0,953	98,41%	0,977	0,974	0,908	30
18	Italy	0,951	98,71%	0,954	0,965	0,935	27
19	Liechtenstein	0,951	100,00%	1,000	0,949	0,903	1
20	New Zealand	0,950	100,00%	0,936	0,993	0,919	1
21	United Kingdom	0,947	97,83%	0,978	0,957	0,906	32
22	Germany	0,947	97,81%	0,975	0,954	0,913	33
23	Singapore	0,944	100,00%	1,000	0,913	0,920	1
24	Hong Kong	0,944	100,00%	1,000	0,879	0,953	1
25	Greece	0,942	98,71%	0,944	0,981	0,902	28
26	Republic of Korea	0,937	99,50%	0,920	0,988	0,904	23

27	Israel	0,935	97,58%	0,930	0,947	0,928	35
28	Andorra	0,934	100,00%	1,000	0,877	0,925	1
29	Slovenia	0,929	97,58%	0,933	0,969	0,886	34
30	Brunei	0,920	100,00%	1,000	0,891	0,867	1
31	Kuwait	0,916	100,00%	1,000	0,872	0,875	1
32	Cyprus	0,914	95,12%	0,920	0,910	0,910	47
33	Qatar	0,910	100,00%	1,000	0,888	0,841	1
34	Portugal	0,909	94,49%	0,906	0,929	0,893	52
35	United Arab Emirates	0,903	100,00%	1,000	0,838	0,872	1
36	Czech Republic	0,903	94,44%	0,916	0,938	0,856	53
37	Barbados	0,903	98,12%	0,866	0,975	0,867	31
38	Malta	0,902	94,70%	0,908	0,887	0,910	50
39	Bahrain	0,895	95,04%	0,950	0,893	0,843	49
40	Estonia	0,883	97,05%	0,887	0,964	0,799	38
41	Poland	0,880	95,88%	0,847	0,952	0,842	44
42	Slovakia	0,880	93,44%	0,885	0,928	0,827	57
43	Hungary	0,879	96,64%	0,874	0,960	0,805	42
44	Chile	0,878	94,00%	0,823	0,919	0,891	54
45	Croatia	0,871	92,17%	0,847	0,916	0,850	63
46	Lithuania	0,870	97,40%	0,863	0,968	0,780	36
47	Antigua and Barbuda	0,868	95,12%	0,873	0,945	0,786	48
48	Latvia	0,866	96,71%	0,851	0,961	0,788	40
49	Argentina	0,866	95,27%	0,815	0,946	0,836	46
50	Uruguay	0,865	96,17%	0,788	0,955	0,852	43
51	Cuba	0,863	100,00%	0,706	0,993	0,891	1
52	Bahamas	0,856	88,79%	0,886	0,878	0,804	93
53	Mexico	0,854	90,00%	0,826	0,886	0,850	78
54	CostaRica	0,854	93,19%	0,782	0,883	0,896	58
55	Libya	0,847	90,38%	0,829	0,898	0,814	74
56	Oman	0,846	90,63%	0,906	0,790	0,841	71
57	Seychelles	0,845	89,23%	0,851	0,886	0,797	89
58	Venezuela	0,844	92,70%	0,801	0,921	0,811	59

59	SaudiArabia	0,843	90,72%	0,907	0,828	0,794	70
60	Panama	0,840	89,49%	0,790	0,888	0,842	85
61	Bulgaria	0,840	93,59%	0,788	0,930	0,802	56
62	SaintKitts and Nevis	0,838	90,16%	0,830	0,896	0,787	76
63	Romania	0,837	92,07%	0,804	0,915	0,792	64
64	Trinidad and Tobago	0,837	91,13%	0,911	0,861	0,737	68
65	Montenegro	0,834	89,70%	0,795	0,891	0,817	81
66	Malaysia	0,829	86,60%	0,819	0,851	0,819	103
67	Serbia	0,826	89,70%	0,773	0,891	0,816	80
68	Belarus	0,826	96,77%	0,782	0,961	0,733	39
69	SaintLucia	0,821	89,52%	0,765	0,889	0,810	84
70	Albania	0,818	90,60%	0,710	0,886	0,858	72
71	Russian Federation	0,817	93,94%	0,833	0,933	0,686	55
72	TheFormerYugoslavRepublicofMacedonia	0,817	88,61%	0,753	0,880	0,819	96
73	Dominica	0,814	90,01%	0,729	0,848	0,865	77
74	Grenada	0,813	89,07%	0,717	0,884	0,838	92
75	Brazil	0,813	89,67%	0,761	0,891	0,787	83
76	Bosnia and Herzegovina	0,812	88,51%	0,726	0,874	0,834	98
77	Colombia	0,807	88,69%	0,743	0,881	0,795	94
78	Peru	0,806	89,70%	0,728	0,891	0,800	82
79	Turkey	0,806	83,36%	0,812	0,828	0,779	117
80	Ecuador	0,806	88,12%	0,719	0,866	0,833	99
81	Mauritius	0,804	84,45%	0,789	0,839	0,785	115
82	Kazakhstan	0,804	97,10%	0,782	0,965	0,666	37
83	Lebanon	0,803	86,32%	0,770	0,857	0,781	104
84	Armenia	0,798	91,49%	0,675	0,909	0,810	66
85	Ukraine	0,796	96,65%	0,707	0,960	0,720	41

86	Azerbaijan	0,787	88,67%	0,728	0,881	0,751	95
87	Thailand	0,783	89,37%	0,734	0,888	0,728	88
88	Iran	0,782	81,15%	0,784	0,793	0,769	126
89	Georgia	0,778	92,18%	0,641	0,916	0,777	62
90	Dominican Republic	0,777	84,50%	0,702	0,839	0,790	114
91	Saint Vincent and the Grenadines	0,772	82,30%	0,725	0,817	0,774	120
92	China	0,772	85,67%	0,665	0,851	0,799	106
93	Belize	0,772	88,52%	0,703	0,762	0,851	97
94	Samoa	0,771	91,10%	0,634	0,905	0,773	69
95	Maldives	0,771	89,07%	0,659	0,885	0,768	91
96	Jordan	0,770	87,56%	0,650	0,870	0,790	101
97	Suriname	0,769	85,58%	0,727	0,850	0,729	107
98	Tunisia	0,769	84,64%	0,721	0,772	0,813	112
99	Tonga	0,768	92,61%	0,605	0,920	0,778	60
100	Jamaica	0,766	83,91%	0,686	0,834	0,778	116
101	Paraguay	0,761	87,67%	0,633	0,871	0,778	100
102	SriLanka	0,759	85,88%	0,626	0,834	0,816	105
103	Gabon	0,755	84,99%	0,838	0,843	0,584	110
104	Algeria	0,754	81,86%	0,726	0,748	0,787	123
105	Philippines	0,751	89,41%	0,589	0,888	0,777	87
106	ElSalvador	0,747	81,31%	0,678	0,794	0,771	125
107	Syria	0,742	85,08%	0,636	0,773	0,818	109
108	Fiji	0,741	87,37%	0,628	0,868	0,728	102
109	Turkmenistan	0,739	91,25%	0,651	0,906	0,661	67
110	Occupied Palestinian Territories	0,737	89,22%	0,519	0,886	0,806	90
111	Indonesia	0,734	84,61%	0,603	0,840	0,758	113
112	Honduras	0,732	82,59%	0,607	0,806	0,783	119
113	Bolivia	0,729	89,77%	0,624	0,892	0,673	79
114	Guyana	0,729	94,56%	0,555	0,939	0,691	51

115	Mongolia	0,727	91,87%	0,580	0,913	0,687	65
116	VietNam	0,725	85,47%	0,544	0,810	0,821	108
117	Moldova	0,720	90,46%	0,541	0,899	0,722	73
118	Equatorial Guinea	0,719	95,54%	0,955	0,787	0,415	45
119	Uzbekistan	0,710	89,43%	0,532	0,888	0,711	86
120	Kyrgyzstan	0,710	92,38%	0,500	0,918	0,710	61
121	Cape Verde	0,708	80,87%	0,570	0,786	0,769	127
122	Guatemala	0,704	78,22%	0,638	0,723	0,752	130
123	Egypt	0,703	77,94%	0,664	0,697	0,749	131
124	Nicaragua	0,699	82,74%	0,542	0,760	0,795	118
125	Botswana	0,694	82,00%	0,820	0,788	0,473	121
126	Vanuatu	0,693	77,85%	0,601	0,728	0,748	132
127	Tajikistan	0,688	90,25%	0,478	0,896	0,691	75
128	Namibia	0,686	81,60%	0,658	0,811	0,590	124
129	SouthAfrica	0,683	84,84%	0,765	0,843	0,442	111
130	Morocco	0,654	79,83%	0,620	0,574	0,767	128
131	Sao Tome and Principe	0,651	81,87%	0,467	0,813	0,673	122
132	Bhutan	0,619	70,52%	0,647	0,533	0,678	141
133	Lao	0,619	69,70%	0,513	0,683	0,659	143
134	India	0,612	66,92%	0,553	0,643	0,639	151
135	Solomon Islands	0,610	70,91%	0,475	0,676	0,680	138
36	Congo	0,601	74,07%	0,594	0,736	0,474	134
137	Cambodia	0,593	70,85%	0,483	0,704	0,593	139
138	Myanmar	0,586	79,23%	0,368	0,787	0,603	129
139	Comoros	0,576	69,26%	0,407	0,655	0,666	145
140	Yemen	0,575	64,96%	0,526	0,574	0,624	153
141	Pakistan	0,572	71,44%	0,537	0,492	0,687	137
142	Swaziland	0,572	73,56%	0,646	0,731	0,339	135
143	Angola	0,564	67,26%	0,665	0,667	0,359	150
144	Nepal	0,553	71,64%	0,392	0,579	0,688	136
145	Madagascar	0,543	68,01%	0,373	0,676	0,582	148

146	Bangladesh	0,543	70,53%	0,420	0,530	0,678	140
147	Kenya	0,541	69,42%	0,457	0,690	0,477	144
148	Papua New Guinea	0,541	61,85%	0,507	0,521	0,594	160
149	Haiti	0,532	62,45%	0,408	0,588	0,600	158
150	Sudan	0,531	56,97%	0,507	0,539	0,548	165
151	Tanzania	0,530	67,76%	0,416	0,673	0,500	149
152	Ghana	0,526	62,59%	0,432	0,622	0,525	156
153	Cameroon	0,523	63,11%	0,510	0,627	0,431	155
154	Mauritania	0,520	55,46%	0,494	0,541	0,526	170
155	Djibouti	0,520	55,75%	0,505	0,554	0,501	168
156	Lesotho	0,514	75,80%	0,457	0,753	0,332	133
157	Uganda	0,514	70,29%	0,394	0,698	0,449	142
158	Nigeria	0,511	66,12%	0,497	0,657	0,378	151
159	Togo	0,499	64,47%	0,345	0,534	0,620	154
160	Malawi	0,493	68,96%	0,339	0,685	0,456	146
161	Benin	0,492	62,49%	0,430	0,445	0,601	157
162	Timor Leste	0,489	61,87%	0,329	0,545	0,595	159
163	Cote d'Ivoire	0,484	55,21%	0,472	0,450	0,531	171
164	Zambia	0,481	68,67%	0,435	0,682	0,326	147
165	Eritrea	0,472	59,33%	0,306	0,539	0,570	163
166	Senegal	0,464	52,64%	0,469	0,417	0,506	173
167	Rwanda	0,460	61,07%	0,360	0,607	0,412	162
168	Gambia	0,456	53,17%	0,418	0,439	0,511	172
169	Liberia	0,442	57,76%	0,215	0,562	0,548	164
170	Guinea	0,435	56,02%	0,406	0,361	0,538	167
171	Ethiopia	0,414	51,59%	0,343	0,403	0,496	174
172	Mozambique	0,402	48,17%	0,348	0,478	0,380	175
173	Guinea Bissau	0,396	55,60%	0,261	0,552	0,375	169
174	Burundi	0,394	56,25%	0,205	0,559	0,418	166
175	Chad	0,392	44,94%	0,449	0,334	0,393	177
176	Democratic Republic of the Congo	0,389	61,26%	0,182	0,608	0,377	161

177	Burkina Faso	0,389	48,10%	0,404	0,301	0,462	176
178	Mali	0,371	40,24%	0,398	0,331	0,385	181
179	Central African Republic	0,369	42,20%	0,328	0,419	0,361	179
180	Sierra Leone	0,365	40,54%	0,320	0,403	0,371	180
181	Afghanistan	0,352	39,31%	0,393	0,354	0,310	182
182	Niger	0,340	44,80%	0,307	0,282	0,431	178

We compared the DEA efficiency scores with HDI values. Pearson correlation coefficient of 0.958 shows that the two indices are highly correlated. Despite this strong correlation, there are also some notable differences between the two measurements.

IV. DISCUSSION

Benchmarks

DEA analysis shows that Australia is the country that is the most frequently used as a reference by the inefficient countries (115 times or by the 63% of the inefficient countries). The corresponding frequencies for Denmark and Japan are 94 (52%) and 58 (32%), respectively. Therefore, both Australia and Denmark can be regarded as role model countries.

Cluster Analysis

The basis of UNDP's classification of 182 countries into 4 groups (shown in Table 2) is based on a simple leveling structure. A better method for determining the real cut-offs between countries is the cluster analysis. In a previous research, Wolff et al. (2009) have examined the consequences of data error in data series used to construct aggregate indicators and found that up to 45% of developing countries were misclassified in HDR 2008. Our analysis of corrected HDI and DEA-based cutoffs are given in Table 3. Grouping of countries by means of cluster analysis is given in Table 4. In addition, the ranking results of DEA have also been examined by cluster analysis. The countries have again been classified in four groups. However, there are substantial differences between the groupings of HDI and DE

Table 2 Classification of countries according to HDR, 2009

	No. of countries	UNDP's lower cut-off (HDI)	UNDP's upper cut-off (HDI)
Very High Human Development 0.900≤HDI≤1.000	38	0.902	0.971
High Human Development 0.800≤HDI<0.900	45	0.803	0.895
Medium Human Development 0.500≤HDI<0.800	75	0.511	0.798
Low Human Development	24	0.340	0.499

HDI<0.500			

Table 3 Corrected and DEA cutoffs classifying the 182 countries

	Group no.	No. of countries	lower cut-off	Upper cut-off
Corrected HDI	1	66	0.829	0.971
	2	63	0.683	0.826
	3	30	0.499	0.654
	4	23	0.340	0.493
DEA	1	84	90.00%	100.00%
	2	57	70.53%	89.49%
	3	33	52.64%	70.29%
	4	8	39.31%	48.17%

Corrected groups of HDI has differed from the former one in many terms. Firstly, Group 1 now includes many of the recently EC-integrated countries such as Estonia, Poland, Slovakia, Hungary, Lithuania, Latvia, Bulgaria and Romania. Secondly, South and Central American countries has appeared in Group 1 for the first time. These countries include Chile, Argentina, Uruguay, Costa Rica, Venezuela, Panama and Trinidad Tobago. It should be noted that Argentina, Uruguay and Venezuela are full members of Mercosur. Thirdly, none of the African countries are categorized in Group 1. Next, Group 2 now includes the majority of Asian, Turkic and North African countries. Last, whereas Group 4 includes mostly the Central African countries.

According to the classification by DEA, all ex-USSR countries except Azerbaijan and Uzbekistan have moved to Group 1 from Group 2 due to their high adult literacy rate. In return, Bahamas and Malaysia have moved to Group 2 from Group 1 due to their relatively low EI.

Equatorial Guinea have moved to Group 1 from Group 2 due to its high GDP per capita of 30.627 USD. In return, Panama has moved from Group 1 to Group 2 due to its relatively low GDP per capita.

Moving from Group 3 to Group 2 has required countries to have superiority over other countries in any of the two indicators. For instance, Pakistan has higher GDP per capita (0.537 versus 0.526) and life expectancy (0.687 versus 0. 624) indices than Yemen. Therefore, Pakistan has moved to the upper group whereas the group of Yemen has remained the same.

It should be noted that high education index is proven to be the most important criterion while grouping the countries by DEA. All countries moving from Group 4 to Group 3 such as Malawi, Zambia and Rwanda have enjoyed relatively higher adult literacy rates. It is also observed that countries with the lowest efficiency scores are mainly from the Central African countries.

	Group 1	Group 2	Group 3	Group 4
Corrected HDI	Norway, Australia, Iceland, Canada, Ireland, Netherlands, Sweden, France, Switzerland, Japan, Luxembourg, Finland, United States, Austria, Spain, Denmark, Belgium, Italy, Liechtenstein, New Zealand, United Kingdom, Germany, Singapore, Hong Kong, reece, Republic of Korea, Israel, Andorra, Slovenia, Brunei, Kuwait, Cyprus, Qatar, Portugal, United Arab mirates, Czech Republic, Barbados, Malta, Bahrain, Estonia, Poland, Slovakia, Hungary, Chile, Croatia, Lithuania, Antigua and Barbuda, Latvia, Argentina, Uruguay, Cuba, Bahamas, Mexico, Costa Rica, Libya, Oman, Seychelles, Venezuela, Saudi Arabia, Panama, Bulgaria, Saint Kitts and Nevis, Romania, Trinidad and Tobago, Montenegro, Malaysia	Serbia, Belarus, Saint Lucia, Albania, Russian Federation, the Former Yugoslav Republic of Macedonia, Dominica, Grenada, Brazil, Bosnia and Herzegovina, Colombia, Peru, Turkey, Ecuador, Mauritius, Kazakhstan, Lebanon, Armenia, Ukraine, Azerbaijan, Thailand, Iran, Georgia, Dominican Republic, Saint Vincent and the Grenadines, China, Belize, Samoa, Maldives, Jordan, Suriname, Tunisia, Tonga, Jamaica, Paraguay, Sri Lanka, Gabon, Algeria, Philippines, El Salvador, Syria, Fiji, Turkmenistan, Occupied Palestinian Territories, Indonesia Honduras, Bolivia, Guyana, Mongolia, Vietnam, Moldova Equatorial Guinea, Uzbekistan, Kyrgyzstan, CapeVerde, Guatemala, Egypt, Nicaragua, Botswana, Vanuatu, Tajikistan, Namibia, South Africa	Morocco, Sao Tome and Principe, hutan, Lao, India, Solomon Islands, Congo, Cambodia, yanmar, Comoros, Yemen, Pakistan, Swaziland, Angola, Nepal, Madagascar, Bangladesh, Kenya, Papua New Guinea, Haiti, Sudan, Tanzania, Ghana, Cameroon, Mauritania, Djibouti, Lesotho, Uganda, Nigeria, Togo	Malawi, Benin, Timor Leste, Cote d'Ivoire, Zambia, Eritrea, Senegal, Rwanda, Gambia, Liberia, Guinea, Ethiopia, Mozambique, Guinea Bissau, Burundi, Chad, Democratic Republic of the Congo, Burkina Faso, Mali, Central African Republic, Sierra Leone Afghanistan, Niger

DEA	Norway, Australia, Iceland, Canada, Ireland, Netherlands, Sweden, France, Switzerland, Japan, Luxembourg, Finland, United States, Austria, Spain, Denmark, Belgium, Italy, Liechtenstein, New Zealand, United Kingdom, Germany, Singapore, Hong Kong, reece, Republic of Korea, Israel, Andorra, Slovenia, Brunei, Kuwait, Cyprus, Qatar, Portugal, United Arab mirates, Czech Republic, Barbados, Malta, Bahrain, Estonia, Poland, Slovakia, Hungary, Chile, Croatia, Lithuania, Antigua and Barbuda, Latvia, Argentina, Uruguay, Cuba, Mexico, Costa Rica, Libya, Oman, Venezuela, Saudi Arabia, Bulgaria, Saint Kitts and Nevis, Romania, Trinidad and Tobago, Montenegro, Serbia, Belarus, Saint Lucia, Albania, Russian Federation, Dominica, Brazil, Peru, Kazakhstan, Armenia, kraine, Georgia, Samoa, Tonga, Turkmenistan, Bolivia, Guyana, Mongolia, Moldova, Equatorial Guinea, Kyrgyzstan, Tajikistan	Bahamas, Seychelles, Panama, , Malaysia, Namibia, South Africa, the Former Yugoslav Republic of Macedonia, Grenada, Bosnia and Herzegovina, Colombia, Turkey, Ecuador, Mauritius, Lebanon, Azerbaijan, Thailand, Iran, Dominican Republic, Saint Vincent and the Grenadines, China, Belize, Maldives, Jordan, Suriname, Tunisia, Jamaica, Paraguay, Sri Lanka, Gabon, Algeria, Philippines, El Salvador, Syria, Fiji, Occupied Palestinian Territories, Indonesia, Honduras, Vietnam, Uzbekistan, Cape Verde, Guatemala, Egypt, Nicaragua, Botswana, Vanuatu, Namibia, South Africa, Morocco, Sao Tome and Principe, Bhutan, Solomon Islands, Congo, Cambodia, Myanmar, Pakistan, Swaziland, Nepal, Bangladesh, Lesotho	Lao, India, Comoros, Yemen, Angola, Madagascar, Kenya, Papua New Guinea, Haiti, Sudan, Tanzania, Ghana, Cameroon, Mauritania, Djibouti, Uganda, Nigeria, Togo	Mozambique, Chad, Burkina Faso, Mali, Central African Republic, Sierra Leone Afghanistan, Niger

V. CONCLUSIONS

It is true that the HDI has brought the global community closer and inspired a united effort in the common cause of improving the human condition for those dwelling in the darkest corners of the world. It is also true that HDI is a simple and universal index. However, this index has been very subjective and not been scientifically successful in correctly categorizing the countries. To overcome this problem, cluster analysis has been used.

The proposed approach in this paper differs from the previous HDI assessments since it does not need to assign any subjective weights to EI, LEI and GDPI. It also differs from the previous DEA applications on HDI assessment by clustering countries by means of DEA-based cutoff points.

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