Multidimensional Poverty Measurement: Development Ranking and Deprivation Ranking

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多次元的貧困の測定：開発ランキングと貧困ランキング

道　中　真　紀*

Abstract

The purpose of this paper is to propose two types of multidimensional poverty rankings among countries without any aggregation or indexation, and to compare them with the ranking of the Human Development Index (HDI). One ranking proposed in this paper highlights 'development' aspects and the other highlights 'deprivation' aspects. The rank differences between these two rankings enable us to capture the distinct processes of multidimensional development in each country that is negated in the HDI ranking.

要　旨

本稿の目的は、データの集計・指数化を用いずに世界の国々の多次元的貧困レベルを順位付ける２種類のランキング方法を提示し、その結果を人間開発指数（Human Development Index: HDI）のランキングと比較することである。本稿で提示されるランキングの一方は「いかにその国が開発されているか」という側面に焦点を当てたランキングであり、もう一方は「いかにその国が貧困であるか」という側面に焦点を当てたランキングである。結果として、この２種類のランキングの順位の差に着目することにより、人間開発指数のランキングでは捉えられなかった各国の開発プロセスの違いの把握が可能となることが示された。

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1 Introduction

This paper proposes two types of ranking methods for ranking the levels of multidimensional poverty among different counties and compares the rankings by these two methods with that of the Human Development Index (HDI). The ranking method suggested in Michinaka (2008) is redefined as Maximal order ranking in this paper.

The traditional approach that regards poverty as a purely economic connotation fails to capture the degree of actual poverty (Wagle 2008, p. 15). Instead of an income-based approach, many others that attempt to conceptualize and measure poverty have been developed. These alternative approaches commonly regard poverty not as a one-dimensional problem but as a multidimensional one and try to capture the multifaceted character of poverty (Some approaches and their failings are summarized in Silber (2007)). Especially, the capability approach proposed by Sen (1985 pp. 9-16) emphasizing that what an individual actually does, rather than what they have, has accelerated studies on multidimensional poverty.

The HDI, one of the most widely consulted multidimensional poverty indices, is also deeply affected by Sen's capability approach. The HDI is a composite index describing the level of multidimensional poverty in each country. The United Nations Development Prog ramme (UNDP) launched the HDI in 1990, and publishes it and its rankings annually in the Human Development Report (HDR). In the first HDR, the UNDP (1990, p. 10) defined human development as a process of enlarging people's choices. This concept is rooted in Sen's capability approach; thus the HDI has been regarded as embodying the capability approach for the practical realization of multidimensional poverty measurement. The HDI chose three fundamental aspects of human development, longevity, knowledge and a decent standard of living, as essential human development aspects (UNDP 1990, pp. 11-12). To represent these three aspects, the HDI has adopted four indicators; life expectancy at birth, the adult literacy rate, the combined gross enrolment ratio for primary, secondly and tertiary schools[1], and GDP per capita in purchasing power parity of US dollars (PPP$). The HDI is a combined index of these four indicators (more details are in the next section).

The HDI succeeds in representing multifaceted poverty in a simple form. However, the specific indicators and formulas aggregating these indicators into one index have been criticized for their arbitrariness. It is said that there are no logical or statistical foundations for accepting the specific indicators and formulas. Searching for foundations, a number of modifications have been proposed in previous works. There have been

[1] This indicator was added to the HDI in 1991. The original HDI published in 1990 consisted of three indicators, that is, the life expectancy at birth, the adult literacy rate and GDP per capita (PPP$).

attempts to eliminate arbitrariness in the selection of indicators representing a multidimensional poverty level; McGillivray (1991) pointed out that there are high correlations among the four indicators of the HDI, so the HDI cannot represent the breadth of human development. Paul (1996) suggested several modifications for the HDI, by adding the infant mortality rate as an indicator. Ranis et al. (2006) identified eleven categories of human development and selected alternative candidates for indicators depending on their correlations. On the other hand, in attempts to eliminate arbitrariness in the aggregation or indexation of the HDI, Noorbakhsh (1998a, 1998b) suggested several modifications for the HDI to account for the diminishing returns to the education indicators and to be relatively less restrictive for the income indicator. Gormely (1995) suggested the use of distinct income indexation formulas depending on the level of GDP per capita (PPP$). Indeed, this method was applied by the United Nations Development Programme (UNDP) from 1995 to 1998. However, Luchters and Menkhoff (1996) pointed out the statistical artifacts of this alternative method. They suggested using a single simple function type for income transformation, such as a logarithmic or an Atkinson-type function. Anand and Sen (1999) proposed a logarithmic transformation formula for income indexation, and this is the formula currently applied by the UNDP. The characterization of the HDI by Chacravarty (2003) contributed axiomatic approaches to the HDI. Chowdhury and Squire (2006) and Chershye et al. (2008) suggest alternative weighting methods for the aggregation process of the HDI.

Despite the number of modifications, a critical question still remains. Why must we aggregate four indicators into one index? No matter how we modify the formulas, each indicator carries some implicit values. For example, there are some reasons why a certain weight is selected, and so on. In short, aggregation itself is arbitrary. Moreover, reducing four indicators to one index weakens the ability to capture the diverse nature of human development. A combined index does not give information about the level of each indicator. A lack of considerations to diversity somewhat contradicts the original concept of the HDI, one of the aims of the HDI being to highlight several distinct aspects of human development.

Based on this motivation, Michinaka (2008) suggested an alternative method for the HDI to rank the levels of multidimensional poverty among countries, without any aggregation or indexation. This method uses the same indicators as the HDI, but substitutes a series of ranking methods for the formulas. The ranking methods are based on two criteria: one is that we do not make value comparisons across different indicators, and the other is that a bigger value of an indicator is better than a smaller one within an indicator. As a result the rankings produced by this method have quite different features from the existing HDI rankings. In the HDI, one country corresponds to one rank, but multiple countries are possible to have the same rank in Michinaka's method, as this method accepts the incomparability of different aspects of poverty. Though Michinaka's method has the advantage of avoiding the arbitrariness in the aggregation or indexation of the HDI, it has a disadvantage as it cannot always produce a complete top-to-bottom ranking list as achieved with the HDI.

Developing the methodology proposed in Michinaka (2008), I propose two methods for ranking the levels of multidimensional poverty among countries in this paper. I first redefine the ranking method in Michinaka (2008) as Maximal order ranking (MAXOR) and define another ranking method called Minimal order ranking (MINOR) as an application of MAXOR. MAXOR and MINOR highlight different aspects of multidimensional poverty. The former sheds light to how a country is hard to be dominated by other countries, and the latter shed light on how a country is easily to be dominated by other countries. Reflecting this difference, the rankings produced by them show quite different features. The difference between MAXOR and MINOR provides valuable information about the features of the development process of each country. Contrarily, the HDI ranking possibly cancels out the information given by these two because it aggregates all of the development indicators into one composite index and sets an equal weight on each indicator.

The rest of this paper is organized as follows: the next section introduces the calculation of the HDI. In section 3, I propose two ranking methods; MAXOR and MINOR. In the section 4, I present ranking results derived from each method and examine their implications. I conclude in the final section.

2 Calculating the HDI

The process of calculating the HDI value is introduced annually in the HDR. Though the basic concept and the calculation method for the HDI have not changed since the beginning, slight modifications have been added over the past seventeen years. The following calculation method is introduced in a technical note to the HDR 2009 on a website (http://hdr.undp.org/en/media/HDR_20072008_EN_Technical1.pdf).

As a mentioned in the last section, the HDI adopts three fundamental aspects of human development, namely, longevity, knowledge and a decent standard of living to capture essential human development aspects. In order to represent these three aspects, four indicators are adopted; the life expectancy at birth, the adult literacy rate, the combined gross enrolment ratio for primary, secondly and tertiary schools, and GDP per capita (PPP$). The HDI is a combined index of these four indicators.

To obtain the HDI value, we first calculate the index value of each indicator. Then, we combine the literacy index value and the enrolment index value to get the gross education index value. Thus we have three index values; the life expectancy index, education index and GDP index values. The HDI value is a simple average of these three values. The formula to calculate an index value of each indicator is as follows:

$$V_c^i = \frac{A_c^i - Min^i}{Max^i - Min^i}$$

Let V_c^i be an index value, where subscript c means a country and the superscript i means a development indicator such as the adult literacy rate. Hence V_c^i denotes an index value of an indicator i for country c and A_c^i denotes the actual value of an indicator i for country c. Let Max^i and Min^i be the fixed maximum and minimum values corresponding to each i respectively.

With respect to the GDP index value, a logarithmically transformation is applied. The reason given by the HDR is that achieving a respectable level of human development does not require unlimited income (See the technical note of the HDR 2009). Then, the formula to calculate GDP index value of country c, namely V_c^G, is

$$V_c^G = \frac{\log\{A_c^G\} - \log\{Min^G\}}{\log\{Max^G\} - \log\{Min^G\}}.$$

The fixed maximum and minimum values of each indicator, in respective order, are as follows: for life expectancy at birth, 85 and 25; for the adult literacy rate, 100 and 0; for the combined gross enrolment ratio, 100 and 25; for GDP per capita (PPP$), 40,000 and 100. Occasionally, the actual value goes beyond the fixed maximum value. For example, the GDP per capita (PPP $) of thirteen countries are over 40,000.

Now we have four index values, that is, the life expectancy index value V_c^L, the literacy index value V_c^{LT}, the enrolment index value V_c^{EN} and GDP index value V_c^G. Next, we combine the literacy index and the enrolment index to get the gross education index V_c^E. The formula is

$$V_c^E = \frac{2}{3}\{V_c^{LT}\} + \frac{1}{3}\{V_c^{EN}\}.$$

Finally, we combine these three index values, that is, life expectancy index, education index and GDP index values. The HDI value is a simple average of these three index values. The formula is as follows:

$$HDI_c = \frac{1}{3}\{V_c^L + V_c^E + V_c^G\}$$

The HDR 2009 calculated and ranked HDI values for 182 countries. The top-ranked country was Norway with an HDI value of 0.971, followed by Australia 0.970 and Iceland 0.969. On the other hand, the bottom-ranked country was Niger at 0.340, followed by Afghanistan 0.352 and Sierra Leone 0.365 (UNDP 2009, pp. 171-175). The HDI values of most countries have seen an upward trend since 1980 (UNDP 2009, pp. 167-170).

3 Maximal Order Ranking and Minimal Order Ranking

In this section I propose two types of method for ranking the levels of multidimensional poverty of countries.

Let us assume that the level of multidimensional poverty for each country is expressed by 'the multidimensional poverty profile,' which is a bundle of the values of the multiple indicators representing the level of poverty, such as GDP per capita, infant mortality rate, and adult literacy rate. These indicators are common among all counties. I also assume that the data of each indicator is expressed by real positive numbers.

Let C be the set of countries and I be the set of the poverty indicators. The number of elements in C and I is denoted as $|C|$ and $|I|$, respectably. Let $\mathbf{R}_+$ denote the set of all positive real numbers and $\boldsymbol{R}^I_+$ is the $|I|$-fold Cartesian product of $\mathbf{R}_+$. The level of multidimensional poverty for any countries in C is described as $f(c) = (f^i_c)_{i \in I}$ where f is the mapping that assigns the $|I|$-dimensional poverty level to a country c in C.

Assume that $\geq$ denotes the binary relationship on C that means 'at least as developed as,' defined as $c \geq \hat{c} :\Leftrightarrow \forall c, \hat{c} \in C \,\&\, \forall i \in I, f^i_c \geq f^i_{\hat{c}}$. Corresponding to $\geq$, I define the three binary relations on C; (1) $\succ$, interpreted as 'strictly developed than,' defined as $c \succ \hat{c} :\Leftrightarrow \forall c, \hat{c} \in C \,\&\, \forall i \in I, f^i_c \geq f^i_{\hat{c}} \,\&\, \exists f^i_c$ such that $f^i_c > f^i_{\hat{c}}$, (2) $\sim$, interpreted as 'as developed as,' defined as $c \sim \hat{c} :\Leftrightarrow \forall c, \hat{c} \in C, \,\&\, \forall i \in I, f^i_c = f^i_{\hat{c}}$, and (3) $\bowtie$, interpreted as 'incomparable,' defined as $c \bowtie \hat{c} :\Leftrightarrow \forall c, \hat{c} \in C, \exists i \in I$ such that $f^i_c > f^i_{\hat{c}} \,\&\, \exists j \in I$ such that $f^j_c < f^j_{\hat{c}}$. Here $\succ$ and $\sim$ are the asymmetric and symmetric factors of $\geq$, and $\bowtie$ is an incomparability relationship corresponding to $\geq$; namely $c \bowtie \hat{c} \Leftrightarrow \neg(c \geq \hat{c}) \,\&\, \neg(\hat{c} \geq c)$[2]. If $c \succ \hat{c} \; \forall c, \hat{c} \in C$ then we regard c dominates $\hat{c}$ so that the binary relation $\succ$ describes Pareto dominance.

Using the above binary relationships, I now define two types of multidimensional poverty ranking rules; Maximal order ranking (MAXOR) and Minimal order ranking (MINOR). Note that both rankings are not orderings over C but are quasi-orderings[3] over C, because of the acceptance of the incomparability of development levels among countries.

As a preliminary indications of the steps to generate MAXOR, I define a maximal set of a set X as follows:

$$\overline{M}(X, \succ) = \{x \mid x \in X \,\&\, \text{there is no } y \in X \text{ such that } y \succ x\}$$

Utilizing the concept of maximal sets, MAXOR is generated by the following

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[2] The symbol $\neg$ denotes the negation of a logical statement.

[3] An ordering is a binary relation satisfying reflexivity, completeness and transitivity. On the other hand, a quasi-ordering satisfies reflexivity and transitivity, but not completeness. See Sen (1970) et al. for details.

recursive steps: (1) Make the maximal set on C, and call it $\overline{M}_1$. (2) Define $C \backslash \overline{M}_1$ as C_1. (3) Again, make the maximal set $\overline{M}_2$ on C_1, namely,

$\overline{M}_2(C_1, \succ) = \{c \mid c \in C_1$ & there is no $\hat{c} \in C_1$ such that $\hat{c} \succ c\}$. (4) In a like manner, consecutively make maximal sets $\overline{M}_i$ on C_{i-1} until $C_{i-1} \backslash \overline{M}_i = \emptyset$. (5) These procedures make a sequence of maximal sets, that is, $\overline{M}_1, \overline{M}_2, \cdots, \overline{M}_i, \cdots, \overline{M}_m$.

For all $c \in \overline{M}_i$, the subscript i corresponds to r^c_{MAXOR} where r^c_{MAXOR} denotes the rank of c in MAXOR. In short, the subscript number of each maximal set denotes the rank of the countries belonging to the maximal set. Hence, MAXOR can be regarded as a partition of a set derived from repeatedly making maximal sets in the set of countries.

Next, I define Minimal order ranking (MINOR) as an application of MAXOR. Similar to MAXOR, I initially define a minimal set of a set X as follows:

$\underline{M}(X, \succ) = \{x \mid x \in X$ & there is no $y \in X$ such that $x \succ y\}$

MINOR over C is derived from similar recursive steps to MAXOR: (1) Make a minimal set on C, and call it $\underline{M}_1$. (2) Define $C \backslash \underline{M}_1$ as C_1. (3) Again, make a minimal set $\underline{M}_2$ on C_1, namely,

$\underline{M}_2(C_1, \succ) = \{c \mid c \in C_1$ & there is no $\hat{c} \in C_1$ such that $c \succ \hat{c}\}$. (4) In like manner, consecutively make maximal sets $\underline{M}_i$ on C_{i-1} until $C_{i-1} \backslash \underline{M}_i = \emptyset$. (5) These procedures make a sequence of minimal sets, that is, $\underline{M}_1, \underline{M}_2, \cdots, \underline{M}_i, \cdots, \underline{M}_m$.

When the number of minimal sets is m, r^c_{MINOR} is defined as $m-i+1$ for all $c \in \underline{M}_i$ where r^c_{MINOR} denotes the rank of c in MINOR. Note that the subscript number of each minimal set does not directly denote the rank of the countries belonging to the minimal set. Similar to MAXOR, MINOR can be regarded as a partition of a set derived from repeatedly making minimal sets in the set of countries.

4 Illustrative Example and Implications

In this section, I give examples of MAXOR and MINOR using the same data used for the HDI. I then compare the results with the HDI rankings and examine their implications.

Applying the ranking methods proposed in the previous section to the data of HDR 2009 (UNDP 2009, pp. 171–175), I re-ranked the 182 countries in line with their multidimensional development levels represented by the four indicators. (See Table). As a result, the 182 countries are ordered in seventeen groups in line with their levels of human development. The result is quite different from the existing HDI rankings.

There is a quite a difference between MAXOR and MINOR. For example, Hong Kong, China (Special Administrative Region: SAR) is ranked first in MAXOR, but seventh in MINOR. Similarly, Andorra ranked second and Equatorial Guinea ranked forth in MAXOR, but in MINOR, the former is ranked tenth and the latter fifteenth.

This difference is attributed to the differences highlighted by each ranking. As the ranking method shows, MAXOR is a ranking describing how a country is hard to be dominated by other countries. The less a country is dominated by other countries, the higher the county is ranked. Especially, a country has at least one extremely high value of an indicator compared with other countries, then that country is difficult to be dominated by other countries. For these reasons, MAXOR can be interpreted as a ranking that highlights the 'development' aspects of each country. On the contrary, MINOR describes how a country is easily to be dominated other countries. The more a country is dominated by other countries, the lower the county is ranked. Hence, MINOR can be interpreted as highlighting the 'deprivation' aspects of each country.

Actually, Hong Kong, China (SAR) achieves a relatively high level of GDP per capita (PPP$), 42,306, ranked eleventh among 182 countries. On the other hand, the enrolment ratio of 74.4 is ranked 88th and is not a high level compared with the level of GDP per capita (PPP $). Because of its relatively high level of GDP per capita (PPP$), Hong Kong, China (SAR) is difficult to be dominated by other country; however, it cannot easily dominate other countries because of the relatively low level of the enrolment ratio. For the same reason, Andorra and Equatorial Guinea have differences between the rank of MAXOR and that of MINOR. Andorra is difficult to be dominated by another country because of its relatively high level of GDP per capita (PPP$) 41,235 (the twelfth among 182 countries), but also it cannot easily dominate other countries because of its relatively low level of enrolment ratio, 65.1 (127th among 182 countries). Equatorial Guinea is one of more extreme cases. It is difficult to be dominated by another country because of its relatively high level of GDP per capita (PPP$) 30,627 (28th among 182 countries), but it cannot easily dominate other countries because of its relatively low level of life expectancy 49.9 (168th among 182 countries).

Paying attention to rank differences between MAXOR and MINOR, we can capture the distinct process of multidimensional development among countries. Some countries with relatively large rank differences between MAXOR and MINOR are considered to simultaneously have both developed and deprived aspects. Contrarily, some countries with relatively small rank differences between MAXOR and MINOR are considered to have relatively balanced development processes. However, the HDI ranking does not capture such differences in the development process of each country, for the HDI aggregates the values of indicators into one combined index so that the differences of values among indicators are canceled out.

For instance, Equatorial Guinea and Uzbekistan have only one rank difference in the HDI for HDR 2009. The HDI ranking of the former is 118 with an HDI value of 0.719, and those of the latter are 119 and 0.710, respectively. The difference in the HDI index is only 0.009. According to the HDI, the levels of development for these countries are almost the same, though the former is slightly better than the latter. However, the values of each indicator of these countries are quite different. Those of Equatorial Guinea, $(f_{EG}^{i})_{i \in I}$ is (49.9, 87.0, 62.0, 30,627) and those of Uzbekistan, $(f_{UZ}^{i})_{i \in I}$ is (67.6, 96.9, 72.7, 2,425). Excepting the value of GDP per capita (PPP$), all of the values of the indicators for Uzbekistan overcome those of Equatorial Guinea. However, the value of GDP per capita (PPP$) of Equatorial Guinea is much bigger than that of Uzbekistan. In such cases, how can we judge which country achieved a better human development level? The HDI is forced to rank these countries uniquely, but a comparison of MAXOR and MINOR gives us better information. The rank difference between MAXOR and MINOR for Equatorial Guinea is eleven (4th in MAXOR and 15th in MINOR), but that of Uzbekistan is only three (9th in MAXOR and 12th in MINOR). It means that the values of each indicator of Equatorial Guinea vary widely, though those of Uzbekistan are relatively balanced.

Finally, the task remaining for the two rankings proposed in this paper. Using these methods, a country ranked higher than another country does not always achieve a higher multidimensional development level compared with the latter. For example, Niger ranked 17th in MAXOR, Sierra Leone and Burkina Faso 16th. The level of Multidimensional poverty of Niger is $(f_{NI}^{i})_{i \in I} = (50.8, 28.7, 27.2, 627)$, that of Sierra Leone $(f_{SL}^{i})_{i \in I} = (47.3, 38.1, 44.6, 679)$ and that of Burkina Faso $(f_{BF}^{i})_{i \in I} = (52.7, 28.7, 32.8, 1{,}124)$, respectively. Following the basic binary relationship defined in the previous section, Niger and Sierra Leone are not comparable. Despite that, they ranked in different places. The reason why Niger is in a group inferior to Sierra Leone is that Niger is dominated by Burkina Faso ranked in the same place as Sierra Leone. It might be unnatural for some people that a country ranked in a higher place does not always have a higher level of multidimensional development than a country ranked in a lower place. One possibility to resolve this problem was that I theoretically re-examined the features of MAXOR and MINOR, and defined another ranking method, called the Pareto dominance order ranking in Michinaka (2009). However, Pareto dominance order ranking also has issues that need resolving.

5 Conclusion

In this paper, I developed the ranking methodology in Michinaka (2008) and proposed two types of method for ranking the levels of multidimensional poverty among countries; Maximal order ranking (MAXOR) and Minimal order ranking (MINOR). Because the former ranking applies the concept of maximal set, it is interpreted as a ranking that highlights ‘development’ aspects in each country. Conversely, the latter is interpreted as a ranking that highlights ‘deprivation’ aspects in each country because of applying the concept of minimal set. Paying attention to differences between the MAXOR and the MINOR rankings, we can obtain valuable information about the distinct processes of the development in each country that is negated in the HDI and its ranking.

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Table: The Human Development Index, Maximal Order Ranking and Minimal Order Ranking

MAXOR	MINOR	HDI		country	life expectancy at birth		adult literacy rate		combined gross enrolment ratio		GDP per capita (PPP$)	
		rank	value		value	rank	value	rank	value	rank	value	rank
1	1	1	0.971	Norway	80.5	12	99.0	1	98.6	8	53433	5
1	2	2	0.970	Australia	81.4	5	99.0	1	100.0	1	34923	22
1	2	3	0.969	Iceland	81.7	3	99.0	1	96.0	13	35742	19
1	2	4	0.966	Canada	80.6	11	99.0	1	99.3	7	35812	18
1	2	7	0.963	Sweden	80.8	8	99.0	1	94.3	17	36712	16
1	3	11	0.960	Luxembourg	79.4	24	99.0	1	94.4	16	79485	2
1	3	16	0.955	Denmark	78.2	34	99.0	1	100.0	1	36130	17
1	4	10	0.960	Japan	82.7	1	99.0	1	86.6	42	33632	26
1	4	19	0.951	Liechtenstein	79.2	26	99.0	1	86.8	41	85382	1
1	5	9	0.960	Switzerland	81.7	3	99.0	1	82.7	49	40658	13
1	7	24	0.944	Hong Kong, China (SAR)	82.2	2	94.6	76	74.4	88	42306	11
2	2	5	0.965	Ireland	79.7	19	99.0	1	97.6	10	44613	10
2	2	6	0.964	Netherlands	79.8	17	99.0	1	97.5	11	38694	14
2	3	8	0.961	France	81.0	7	99.0	1	95.4	15	33674	25
2	3	12	0.959	Finland	79.5	22	99.0	1	100.0	1	34526	23
2	3	14	0.955	Austria	79.9	16	99.0	1	90.5	27	37370	15
2	3	20	0.950	New Zealand	80.1	15	99.0	1	100.0	1	27336	32
2	4	13	0.956	United States	79.1	28	99.0	1	92.4	21	45592	9
2	4	15	0.955	Spain	80.7	9	97.9	53	96.5	12	31560	27
2	4	18	0.951	Italy	81.1	6	98.9	47	91.8	23	30353	29
2	6	23	0.944	Singapore	80.2	14	94.4	79	85.0	46	49704	7
2	7	30	0.920	Brunei Darussalam	77.0	38	94.9	73	77.7	74	50200	6
2	7	31	0.916	Kuwait	77.5	36	94.5	78	72.6	100	47812	8
2	7	33	0.910	Qatar	75.5	48	93.1	86	80.4	57	74882	3
2	8	35	0.903	United Arab Emirates	77.3	37	90.0	99	71.4	107	54626	4
2	10	28	0.934	Andorra	80.5	12	99.0	1	65.1	127	41235	12
3	3	17	0.953	Belgium	79.5	22	99.0	1	94.3	17	34935	21
3	4	21	0.947	United Kingdom	79.3	25	99.0	1	89.2	34	35130	20
3	4	22	0.947	Germany	79.8	18	99.0	1	88.1	37	34401	24
3	4	26	0.937	Korea (Republic of)	79.2	26	99.0	1	98.5	9	24801	35
3	5	25	0.942	Greece	79.1	29	97.1	60	100.0	1	28517	31
3	5	27	0.935	Israel	80.7	9	97.1	60	89.9	33	26315	34
3	7	51	0.863	Cuba	78.5	33	99.0	1	100.0	1	6876	95
4	4	29	0.929	Slovenia	78.2	34	99.0	1	92.8	20	26753	33
4	5	37	0.903	Barbados	77.0	38	99.0	1	92.9	19	17956	48
4	6	32	0.914	Cyprus	79.6	20	97.7	56	77.6	75	24789	36
4	6	34	0.909	Portugal	78.6	31	94.9	73	88.8	35	22765	42
4	6	44	0.878	Chile	78.5	32	96.5	66	82.5	50	13880	59
4	7	38	0.902	Malta	79.6	20	92.4	89	81.3	54	23080	39
4	8	39	0.895	Bahrain	75.6	47	88.8	105	90.4	28	29723	30
4	8	55	0.847	Libyan Arab Jamahiriya	73.8	64	86.8	114	95.8	14	14364	57
4	15	118	0.719	Equatorial Guinea	49.9	168	87.0	113	62.0	133	30627	28
5	5	36	0.903	Czech Republic	76.4	42	99.0	1	83.4	48	24144	37
5	6	40	0.883	Estonia	72.9	74	99.0	1	91.2	25	20361	43
5	6	41	0.880	Poland	75.5	48	99.0	1	87.7	39	15987	53
5	6	43	0.879	Hungary	73.3	69	98.9	47	90.2	30	18755	46
5	6	49	0.866	Argentina	75.2	53	97.6	57	88.6	36	13238	62

Table (continued)

MAXOR	MINOR	HDI		country	life expectancy at birth		adult literacy rate		combined gross enrolment ratio		GDP per capita (PPP$)	
		rank	value		value	rank	value	rank	value	rank	value	rank
5	7	46	0.870	Lithuania	71.8	91	99.0	1	92.3	22	17575	49
5	7	50	0.865	Uruguay	76.1	43	97.9	53	90.9	26	11216	70
5	8	54	0.854	Costa Rica	78.7	30	95.9	70	73.0	98	10842	73
5	8	73	0.814	Dominica	76.9	40	88.0	108	78.5	65	7893	83
5	9	70	0.818	Albania	76.5	41	99.0	1	67.8	122	7041	93
6	6	42	0.880	Slovakia	74.6	56	99.0	1	80.5	56	20076	45
6	6	45	0.871	Croatia	76.0	44	98.7	49	77.2	77	16027	52
6	7	47	0.868	Antigua and Barbuda	72.2	84	99.0	1	85.6	45	18691	47
6	7	48	0.866	Latvia	72.3	83	99.0	1	90.2	30	16377	51
6	7	53	0.854	Mexico	76.0	44	92.8	87	80.2	58	14104	58
6	7	58	0.844	Venezuela (Bolivarian Republic of)	73.6	66	95.2	72	85.9	44	12156	65
6	7	60	0.840	Panama	75.5	48	93.4	83	79.7	59	11391	67
6	7	61	0.840	Bulgaria	73.1	72	98.3	52	82.4	51	11222	69
6	8	52	0.856	Bahamas	73.2	71	95.8	71	71.8	103	20253	44
6	8	57	0.845	Seychelles	72.8	76	91.8	92	82.2	52	16394	50
6	8	78	0.806	Peru	73.0	73	89.6	102	88.1	37	7836	85
6	9	56	0.846	Oman	75.5	48	84.4	118	68.2	118	22816	41
6	9	59	0.843	Saudi Arabia	72.7	77	85.0	117	78.5	65	22935	40
6	9	68	0.826	Belarus	69.0	111	99.0	1	90.4	28	10841	74
6	10	82	0.804	Kazakhstan	64.9	130	99.0	1	91.4	24	10863	72
6	11	64	0.837	Trinidad and Tobago	69.2	110	98.7	49	61.1	137	23507	38
7	7	65	0.834	Montenegro	74.0	61	96.4	67	74.5	86	11699	66
7	8	62	0.838	Saint Kitts and Nevis	72.2	84	97.8	55	73.1	96	14481	56
7	8	63	0.837	Romania	72.5	80	97.6	57	79.2	61	12369	64
7	8	66	0.829	Malaysia	74.1	58	91.9	91	71.5	105	13518	61
7	8	69	0.821	Saint Lucia	73.6	66	94.8	75	77.2	77	9786	77
7	8	72	0.817	Macedonia (the Former Yugoslav Rep. of)	74.1	58	97.0	62	70.1	113	9096	80
7	8	74	0.813	Grenada	75.3	52	96.0	69	73.1	96	7344	92
7	8	75	0.813	Brazil	72.2	84	90.0	99	87.2	40	9567	79
7	8	76	0.812	Bosnia and Herzegovina	75.1	54	96.7	65	69.0	114	7764	87
7	8	77	0.807	Colombia	72.7	77	92.7	88	79.0	63	8587	81
7	8	84	0.798	Armenia	73.6	66	99.0	1	74.6	85	5693	100
7	8	89	0.778	Georgia	71.6	96	99.0	1	76.7	81	4662	110
7	9	80	0.806	Ecuador	75.0	55	91.0	94	77.8	73	7449	91
7	9	99	0.768	Tonga	71.7	92	99.0	1	78.0	70	3748	120
7	10	71	0.817	Russian Federation	66.2	122	99.0	1	81.9	53	14690	55
7	10	85	0.796	Ukraine	68.2	116	99.0	1	90.0	32	6914	94
7	10	86	0.787	Azerbaijan	70.0	107	99.0	1	66.2	124	7851	84
7	10	93	0.772	Belize	76.0	46	75.1	134	78.3	67	6734	96
7	10	98	0.769	Tunisia	73.8	64	77.7	130	76.2	83	7520	90
7	10	105	0.751	Philippines	71.6	96	93.4	83	79.6	60	3406	124
7	12	110	0.737	Occupied Palestinian Territories	73.3	69	93.8	82	78.3	67	2243	135
7	13	103	0.755	Gabon	60.1	144	86.2	115	80.7	55	15167	54
8	8	67	0.826	Serbia	73.9	63	96.4	67	74.5	86	10248	75
8	9	79	0.806	Turkey	71.7	92	88.7	106	71.1	109	12955	63
8	9	81	0.804	Mauritius	72.1	88	87.4	112	76.9	79	11296	68
8	9	83	0.803	Lebanon	71.9	90	89.6	102	78.0	70	10109	76

Table (continued)

MAXOR	MINOR	HDI		country	life expectancy at birth		adult literacy rate		combined gross enrolment ratio		GDP per capita (PPP$)	
		rank	value		value	rank	value	rank	value	rank	value	rank
8	9	94	0.771	Samoa	71.4	98	98.7	49	74.1	90	4467	113
8	9	95	0.771	Maldives	71.1	102	97.0	62	71.3	108	5196	104
8	9	96	0.770	Jordan	72.4	81	91.1	93	78.7	64	4901	107
8	9	100	0.766	Jamaica	71.7	92	86.0	116	78.1	69	6079	98
8	10	102	0.759	Sri Lanka	74.0	61	90.8	95	68.7	116	4243	116
8	10	107	0.742	Syrian Arab Republic	74.1	58	83.1	121	65.7	125	4511	112
8	11	87	0.783	Thailand	68.7	113	94.1	81	78.0	70	8135	82
8	11	109	0.739	Turkmenistan	64.6	132	99.0	1	73.9	92	4953	106
8	11	113	0.729	Bolivia	65.4	128	90.7	96	86.0	43	4206	117
8	11	114	0.729	Guyana	66.5	119	99.0	1	83.9	47	2782	127
8	11	115	0.727	Mongolia	66.2	122	97.3	59	79.2	61	3236	125
8	11	117	0.720	Moldova	68.3	115	99.0	1	71.6	104	2551	131
8	11	120	0.710	Kyrgyzstan	67.6	117	99.0	1	77.3	76	2006	141
8	12	116	0.725	Viet Nam	74.3	57	90.3	98	62.3	130	2600	129
8	14	125	0.694	Botswana	53.4	160	82.9	122	70.6	111	13604	60
9	9	92	0.772	China	72.9	74	93.3	85	68.7	116	5383	102
9	9	101	0.761	Paraguay	71.7	92	94.6	76	72.1	101	4433	114
9	10	88	0.782	Iran (Islamic Republic of)	71.2	101	82.3	123	73.2	95	10955	71
9	10	90	0.777	Dominican Republic	72.4	81	89.1	104	73.5	94	6706	97
9	10	91	0.772	Saint Vincent and the Grenadines	71.4	98	88.1	107	68.9	115	7691	89
9	10	104	0.754	Algeria	72.2	84	75.4	133	73.6	93	7740	88
9	10	106	0.747	El Salvador	71.3	100	82.0	125	74.0	91	5804	99
9	10	112	0.732	Honduras	72.0	89	83.6	120	74.8	84	3796	119
9	11	97	0.769	Suriname	68.8	112	90.4	97	74.3	89	7813	86
9	11	123	0.703	Egypt	69.9	108	66.4	149	76.4	82	5349	103
9	12	119	0.710	Uzbekistan	67.6	117	96.9	64	72.7	99	2425	133
9	12	124	0.699	Nicaragua	72.7	77	78.0	129	72.1	101	2570	130
9	12	127	0.688	Tajikistan	66.4	120	99.0	1	70.9	110	1753	145
9	14	129	0.683	South Africa	51.5	164	88.0	108	76.8	80	9757	78
10	10	111	0.734	Indonesia	70.5	105	92.0	90	68.2	118	3712	121
10	11	108	0.741	Fiji	68.7	113	94.4	79	71.5	105	4304	115
10	11	121	0.708	Cape Verde	71.1	102	83.8	119	68.1	120	3041	126
10	11	122	0.704	Guatemala	70.1	106	73.2	138	70.5	112	4562	111
10	13	128	0.686	Namibia	60.4	143	88.0	108	67.2	123	5155	105
10	13	130	0.654	Morocco	71.0	104	55.6	162	61.0	138	4108	118
10	13	132	0.619	Bhutan	65.7	126	52.8	167	54.1	152	4837	108
10	16	143	0.564	Angola	46.5	178	67.4	147	65.3	126	5385	101
11	11	126	0.693	Vanuatu	69.9	108	78.1	128	62.3	130	3666	122
11	13	131	0.651	Sao Tome and Principe	65.4	129	87.9	111	68.1	120	1638	149
11	14	136	0.601	Congo	53.5	159	81.1	126	58.6	144	3511	123
11	15	138	0.586	Myanmar	61.2	137	89.9	101	56.3	149	904	168
11	16	142	0.572	Swaziland	45.3	179	79.6	127	60.1	141	4789	109
12	12	134	0.612	India	63.4	134	66.0	150	61.0	138	2753	128
12	13	133	0.619	Lao People's Democratic Republic	64.6	132	72.7	139	59.6	142	2165	136
12	13	137	0.593	Cambodia	60.6	142	76.3	132	58.5	145	1802	144
12	14	135	0.610	Solomon Islands	65.8	125	76.6	131	49.7	162	1725	146
12	14	141	0.572	Pakistan	66.2	122	54.2	164	39.3	174	2496	132
12	14	144	0.553	Nepal	66.3	121	56.5	160	60.8	140	1049	166

Table (continued)

MAXOR	MINOR	HDI		country	life expectancy at birth		adult literacy rate		combined gross enrolment ratio		GDP per capita (PPP$)	
		rank	value		value	rank	value	rank	value	rank	value	rank
12	14	146	0.543	Bangladesh	65.7	126	53.5	165	52.1	158	1241	156
12	15	145	0.543	Madagascar	59.9	145	70.7	143	61.3	136	932	167
12	15	147	0.541	Kenya	53.6	158	73.6	136	59.6	142	1542	150
12	15	157	0.514	Uganda	51.9	163	73.6	136	62.3	130	1059	164
12	16	156	0.514	Lesotho	44.9	180	82.2	124	61.5	135	1541	151
12	16	160	0.493	Malawi	52.4	162	71.8	142	61.9	134	761	173
12	16	162	0.489	Timor-Leste	60.7	140	50.1	168	63.2	129	717	174
12	16	164	0.481	Zambia	44.5	181	70.6	144	63.3	128	1358	153
13	13	140	0.575	Yemen	62.5	135	58.9	158	54.4	151	2335	134
13	14	149	0.532	Haiti	61.0	138	62.1	155	52.1	158	1155	159
13	14	150	0.531	Sudan	57.9	147	60.9	156	39.9	173	2086	138
13	14	152	0.526	Ghana	56.5	152	65.0	151	56.5	148	1334	154
13	15	139	0.576	Comoros	64.9	130	75.1	134	46.4	169	1143	160
13	15	151	0.530	Tanzania (United Republic of)	55.0	156	72.3	140	57.3	147	1208	158
13	15	153	0.523	Cameroon	50.9	165	67.9	146	52.3	156	2128	137
13	16	158	0.511	Nigeria	47.7	173	72.0	141	53.0	154	1969	142
13	17	155	0.520	Djibouti	55.1	155	70.3	145	25.5	182	2061	140
13	17	169	0.442	Liberia	57.9	147	55.5	163	57.6	146	362	180
14	14	148	0.541	Papua New Guinea	60.7	140	57.8	159	40.7	172	2084	139
14	14	154	0.520	Mauritania	56.6	151	55.8	161	50.6	160	1927	143
14	14	161	0.492	Benin	61.0	138	40.5	174	52.4	155	1312	155
14	15	159	0.499	Togo	62.2	136	53.2	166	53.9	153	788	171
14	16	167	0.460	Rwanda	49.7	169	64.9	152	52.2	157	866	169
14	16	172	0.402	Mozambique	47.8	172	44.4	171	54.8	150	802	170
14	17	165	0.472	Eritrea	59.2	146	64.2	154	33.3	178	626	178
14	17	174	0.394	Burundi	50.1	167	59.3	157	49.0	164	341	181
14	17	176	0.389	Congo (Democratic Republic of the)	47.6	174	67.2	148	48.2	166	298	182
15	15	163	0.484	Cote d'Ivoire	56.8	150	48.7	169	37.5	175	1690	147
15	15	166	0.464	Senegal	55.4	154	41.9	173	41.2	171	1666	148
15	15	168	0.456	Gambia	55.7	153	42.5	172	46.8	168	1225	157
15	15	170	0.435	Guinea	57.3	149	29.5	178	49.3	163	1140	161
15	16	171	0.414	Ethiopia	54.7	157	35.9	176	49.0	164	779	172
15	17	173	0.396	Guinea-Bissau	47.5	175	64.6	153	36.6	176	477	179
15	17	181	0.352	Afghanistan	43.6	182	28.0	181	50.1	161	1054	165
16	16	177	0.389	Burkina Faso	52.7	161	28.7	179	32.8	179	1124	162
16	17	175	0.392	Chad	48.6	170	31.8	177	36.5	177	1477	152
16	17	178	0.371	Mali	48.1	171	26.2	182	46.9	167	1083	163
16	17	179	0.369	Central African Republic	46.7	177	48.6	170	28.6	180	713	175
16	17	180	0.365	Sierra Leone	47.3	176	38.1	175	44.6	170	679	176
17	17	182	0.340	Niger	50.8	166	28.7	179	27.2	181	627	177

Notes:
1. This table was made by the author based on the data of the Human Development Report 2009 (UNDP 2009).
2. The HDI rank is determined using HDI values to the sixth decimal point.
3. The most of developed countries do not maintain the statistics of adult literacy rate, and the UNDP applies 99.0% to these countries. To keep a consistency with these countries, the author applied 99.0% to the countries that achieved over 99.0% adult literacy rate.
4. Though the value of combined gross enrolment ratio of some countries are over 100.0 in the HDR 2009, the author applied 100.0 to these countries.

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