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Abstract

The conventional measure of Human Development Index (HDI) is a linear average across dimensions, HDI1. Under this, poor attainments in any dimension gets perfectly compensated for better attainments in any other dimension HDI2, which is based on Euclidean distance measuring shortfall from the ideal, addresses the above anomaly. In our analysis of progress, we use HDI2 to develop the notion of an ideal path and penalty to capture deviation from this; and a measure of fluctuation. The measures are applied to 127 countries for the period 1990-2004. The results show that Sub-Saharan countries have suffered on account of sharp decline in health suggesting prevalence of human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) epidemic. In case of Commonwealth of Independent States (CIS), the income dimension got jolted in the nineties indicating their economic collapse after Soviet disintegration. We also find some of the emerging economies progressing well along the ideal path. On the eve of the 20th anniversary of Human Development Report, this paper is timely and would engage academia and public policy to have a critical look favouring a balanced development across the three dimensions of HDI – health, education and standard of living.

Keywords:

Human Development Index (HDI), Ideal path, Measure of fluctuation, Measure of normalized-change, Sub-Saharan, Commonwealth of Independent States (CIS)

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1 Introduction

The history of Human Development Index (HDI) is relatively short. Since the inception of HDI by the United Nation Development Programme (UNDP) in 1990, it has gone through various refinements and contributed to policy discourse.[1] It also has its share of criticisms.[2] Nevertheless, wide acceptance of HDI can be attributed to the following reasons. HDI has been successful in taking the debate from a one-dimensional income-based measure like Gross National Product (GNP) to a three-dimensional measure based on education, health and income. There has been a paradigm shift in terms of consideration of human beings as ends, rather than means of production only. Further, annual computation of HDI and its components through Human Development Reports (HDRs) allows cross-sectional comparison of relative position of countries and provided the scope for time series study on the movement of countries in HDI space. In this paper, we intend to analyse the trends in HDI for selected countries for the time period 1990 to 2004.

In human development, each dimension is intrinsic (Sen, 1999). And hence, if attainment in any dimension is relatively lower, future emphasis ought to be more towards this dimension. A study on movement of countries in HDI space over time reveals how the countries have given relative importance to different dimensions. To illustrate, let us consider the Sub-Saharan Africa region where poor health infrastructure coupled with the human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) epidemic has

[1] For evolution of HDI see Desai (1991), Streeten (1994), Haq (1995), Sen (2000), Raworth and Stewart (2003), and Jahan (2003) among others.

[2] One of the major criticisms of HDI is its use of income component, which may be partly correlated to health and education dimensions. However, inclusion of income in 'HDI is strictly as a residual catch-all, to reflect something of other basic capabilities not already incorporated in the measures of longevity and education.' (Anand and Sen, 2000, p.86).

led to a low life expectancy.[3] Consequently, the countries of the region do not fair well in the health dimension of HDI. For example, in 2005 Swaziland's health index is 0.265 (average life expectancy 40.9 years), whereas the education and income indices are 0.730 and 0.647 respectively (UNDP, 2007). Hence, Swaziland should give higher importance to health dimension, otherwise what relevance is higher level of education and income for people if they are not going to live beyond 40 years!

2 Two methods of construction of HDI

The normalized scores in three dimensions of heath (h), education (e) and income (y) are aggregated to construct HDI by two techniques. The conventional method can be termed as 'linear averaging' (LA), which assumes perfect substitutability across the dimensions.[4] It is expressed as

$$HDI_1 = \frac{h+e+y}{3}. \tag{1}$$

The second method of computation of HDI is based on 'displaced ideal' (DI) method, where the index is calculated as the inverse of the Euclidian distance measuring shortfall from the ideal. HDI under DI is expressed as

$$HDI_2 = 1 - \frac{\sqrt{(1-h)^2 + (1-e)^2 + (1-y)^2}}{\sqrt{3}}. \tag{2}$$

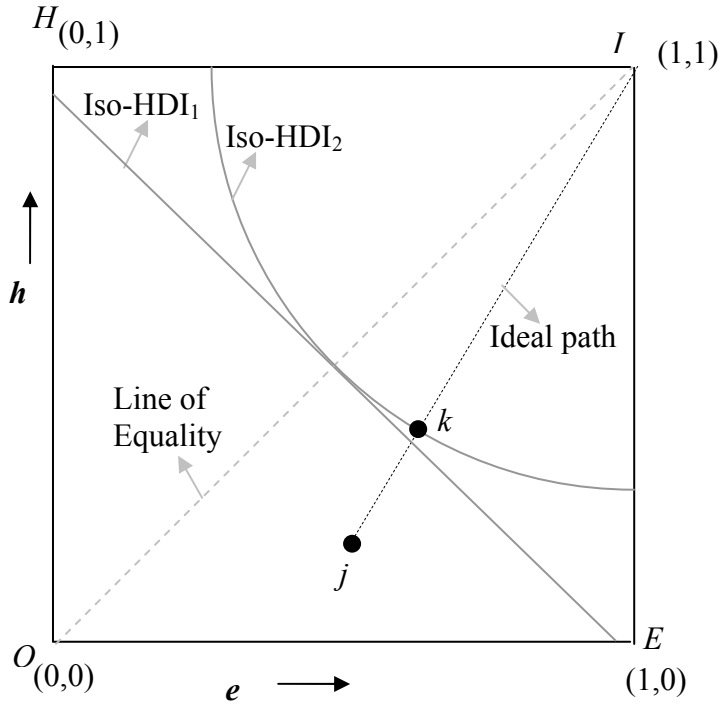
Based on Minkowski distance function, these two turn out to be first and second order measures of an α-class of human development indices,[5]

$$HDI_\alpha = 1 - \left(\frac{(1-h)^\alpha + (1-e)^\alpha + (1-y)^\alpha}{3} \right)^{\frac{1}{\alpha}} \alpha = [1, \infty). \tag{3}$$

[3] All the countries which have average life expectancy less than 50 years belong to this region (UNDP, 2007).
[4] Perfect substitutability means that any increment in one dimension at any value can be substituted or neutralized by an equal decrement in another dimension at any other value.
[5] The difference between LA and DI methods and α-class of HDI measures based on Minkowski distance function are discussed in Nathan, Mishra and Reddy (2008) and Mishra and Nathan (2008) respectively.

Figure 1 shows HDI space in two dimensions by taking health and education for illustration. There is an increment in HDI from any position *j* to a certain higher value for which iso-HDI lines are plotted for HDI_1 and HDI_2.[6] All the points in iso-HDI_1 line are first order equidistant from *j* as the algebraic sum of movement from *j* to any of the points in iso-HDI_1 is constant. Thus, under HDI_1, increment remains path-invariant. However, the second order distance from *j* to different points in iso-HDI_2 vary and it minimises at *k*, which is along the line joining *j* and ideal, *I*. This brings us to the notion of ideal path and path penalty.

Figure 1 HDI_1, HDI_2 and ideal path



Note: Line of equality gives the locus of all points for which all dimensions share equal values; thence on line of equality HDI_1=HDI_2.

3 Ideal path and path penalty

HDI_2 signals the societies to progress along an ideal path which is based on the notion that improvement in a dimension that has lower value is more important than an equivalent

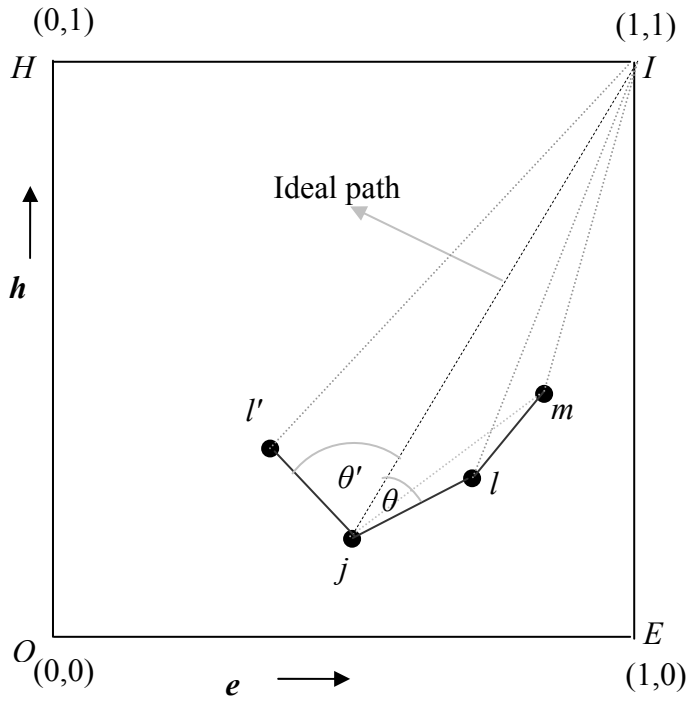
[6] In HDI space, the iso-HDI_1 loci are inclined triangular planes indicating same HDI_1, the corresponding locus in two dimension will be 45^0 inclined (or backward hatched) lines. For HDI_2, concentric quarter spheres with centre being ideal are iso-HDI_2 loci indicating common HDI_2, the corresponding locus in two dimensions are concentric quarter circles.

improvement in a dimension that has higher value. Figure 1 shows the ideal path, *jI*, for a given position *j*. Ideal path gives the direction of progress where the emphases along the dimensions are in proportion to their respective shortfall. In other words, given a position and increment, improvement in HDI_2 is maximized when the movement is along the ideal path.

Any deviation from the ideal path is captured through path penalty, Figure 2. For any path, say *jl*, path penalty, Q_{jl}, is the excess distance covered to reach ideal,[7]

$$Q_{jl} = jl + lI - jI \,. \tag{4}$$

Figure 2 Path penalty



Further, greater is the deviation from the ideal path, the higher is the penalty. Mathematically, from Figure 2, if $\theta' \geq \theta$ and $jl' \geq jl$ then $Q_{jl'} > Q_{jl}$. The normalized penalty can be obtained as ${}_N Q_{jl} = Q_{jl}/2\sqrt{2}$.[8]

For a further movement, say *lm*, the path penalty is given by $Q_{lm}=(lm+mI-lI)$. Cumulative path penalty, Q^c, for *j* to *m* through *l*, $Q^c = Q_{jl}+Q_{lm}=(jl+lm+mI-jI)$. Thus

[7] Under HDI_1, path penalty is zero as the first order distance $jl+lI=jI$.
[8] Normalized path penalty is obtained by dividing by maximum possible path penalty, which is $2\sqrt{2}$, that is, for the path from ideal, *I* to origin, *O*.

generalizing, for a series of movements (s_1,s_2,..,s_n) cumulative path penalty is obtained by summing up of the distances between consecutive positions and adding to it the distance from the last position to the ideal and subtracting from this the distance between the initial position and the ideal,

$$Q^c = \sum_{1}^{n-1} s_i s_{i+1} + s_n I - s_1 I , \tag{5}$$

If the path is closed, that is, the country returns back to the original position, then $Q^c=\sum s_i s_{i+1}$, as the last two terms cancel each other. The cumulative penalty can be normalized as ${}_N Q^c = Q^c/(2n\sqrt{2})$, where n is the number of path segments between the first and last positions.

4 A measure of fluctuation

For a given initial position (s_1) and final position (s_n), the movement is minimized when the intermediate positions (s_2,s_3,..,s_{n-1}) lie on the straight line $s_1 s_n$. Thus, for a given series of positions (s_1,s_2,..,s_n), a measure of fluctuation, F, can be conceptualized as,

$$F = 1 - \frac{s_1 s_n}{\sum_{1}^{n-1} s_i s_{i+1}} , \tag{6}$$

where $\sum s_i s_{i+1}$ is the actual distance in the movement from s_1 to s_n.

4.1 Properties of F

Normalization: A measure for fluctuation in HDI movement has a minimum and a maximum $F \in [0,1]$. At its minimum, $F=0$ corresponds to single straight line movement. At its maximum, $F=1$ indicates movement along closed path.

Monotonicity: Higher the fluctuation in movement, greater is F. In other words, F will increase (decrease) if the ratio of minimum distance to actual distance increases (decreases).

5 A measure of normalized-change in HDI

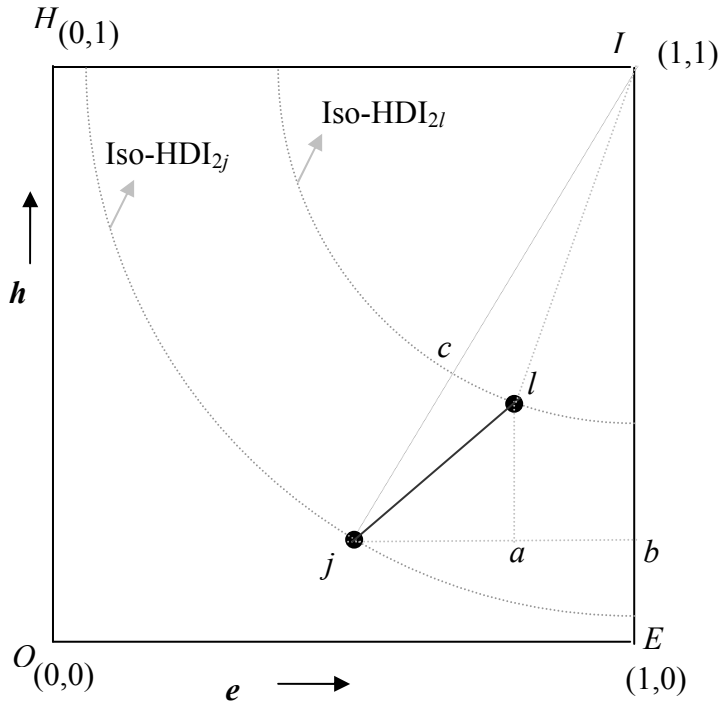
To assess change in human development a measure is conceptualized to capture reduction in shortfall or attainment. This is calculated by taking positive change as a ratio of the initial

shortfall and negative change as a ratio of the initial achievement. This measure of normalized-change is indicated as,

$$G_\alpha = \frac{HDI_{\alpha l} - HDI_{\alpha j}}{1 - HDI_{\alpha j}} \quad if\ HDI_{\alpha l} > HDI_{\alpha j} \\ = \frac{HDI_{\alpha l} - HDI_{\alpha j}}{HDI_{\alpha j}} \quad if\ HDI_{\alpha l} < HDI_{\alpha j} \quad ; \tag{7}$$

where $HDI_{\alpha j}$ and $HDI_{\alpha l}$ correspond to initial and final value in a movement. This has been computed for both HDI_1 and HDI_2 and discussed in the empirical section. Figure 3 shows G_1 and G_2 for a two dimensional case (*h,e*).

Figure 3 Measure of normalized-change in HDI



Note: Geometrically, G_1=(*ja*+*la*)/(*jb*+*Ib*) and G_2=*Ic*/*Ij*.

5.1 Properties of G

A measure of normalized-change in HDI has the following axiomatic properties.

Normalization: A measure for normalized-change in HDI has a minimum and a maximum $G \in [-1,1]$. At its minimum, G=-1 indicates that with the change there is complete failure in all the dimensions (h=0, e=0, y=0). At its maximum, G=1 indicates that with the

change there is full attainment in all the dimensions (h=1, e=1, y=1). For, G=0, there is no change. Both G_1 and G_2 satisfy normalization. For *jI*, G_α=1 and for *jO*, G_α=-1.

Monotonicity: A measure for normalized-change in HDI will increase (decrease) if the final HDI value increases (decreases) with the initial value remaining constant. If initial and final HDI are denoted as $HDI_{\alpha j}$ and $HDI_{\alpha l}$ respectively then with two countries c_1 and c_2 this would mean that for $c_1HDI_{\alpha j}=c_2HDI_{\alpha j}$; $c_1G_\alpha \gtreqless c_2G_\alpha$ iff $c_1HDI_{\alpha l} \gtreqless c_2HDI_{\alpha l}$. Both G_1 and G_2 satisfy this. For a given initial position, j, and final positions l and l'; $G_{\alpha jl'}>G_{\alpha jl'}$ as $HDI_{\alpha l'}>HDI_{\alpha l'}$.

Signalling at aggregate level: A measure for normalized-change in HDI should signal countries at lower level of HDI to improve more than the countries at higher level. In other words to attain the same change in HDI the country with a higher shortfall has to improve more than the countries at lower shortfall. Putting differently, stagnancy in HDI in a country that has a lower value is more serious. This axiom supports the view that emphasis (both society's internal drive and more so for external assistance) ought to be relatively more for countries at lower level of HDI. Both G_1 and G_2 satisfy this axiom as from (7) at a lower (higher) level of HDI, we start with a higher (lower) base for positive change and lower (higher) base for negative change.

Signalling at component level:[9] A measure for normalized-change in HDI should signal a country to emphasize more on the dimension that has a lower value. This is in line with the notion of human development that each dimension is intrinsic (Sen 1999); and for progress, the country needs to do well in all dimensions. A corollary to this axiom is that an improvement in a dimension that has lower value bears greater importance. G_1 fails to satisfy this axiom, whereas G_2 satisfies. This follows from the discussion on path penalty.

[9] This axiom is same as the signalling axiom imposed on the class of HDI measure proposed in a companion paper.

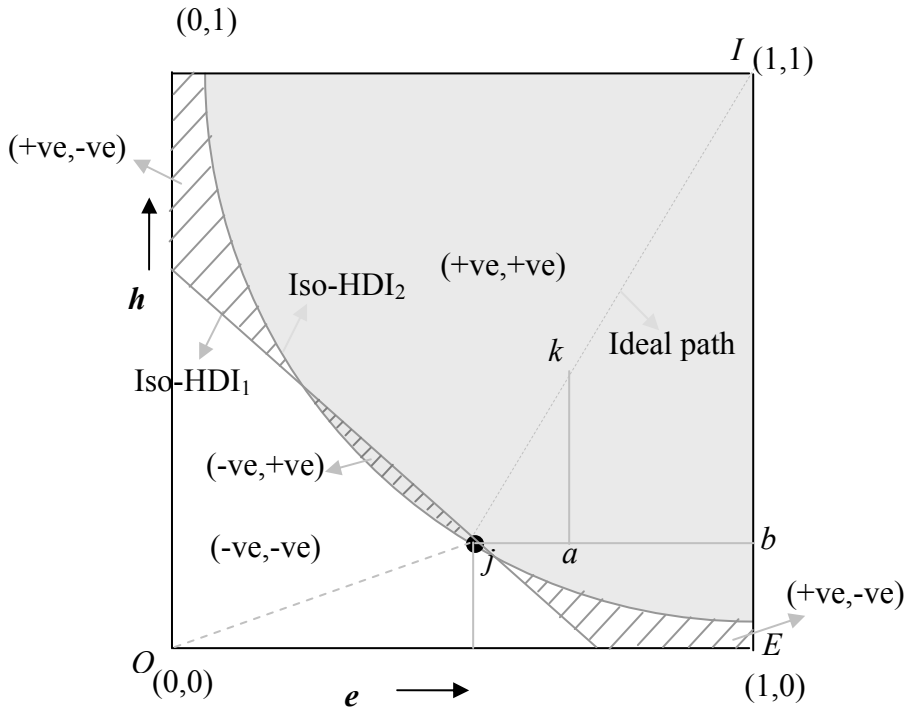
5.2 Positive and negative values of G

The rise and fall in HDI is indicated by positive and negative value of G. Figure 5 shows for a given position, j, the positive and negative zones of G_1 and G_2.

For a given position, j, values of both G_1 and G_2 coincide on the ideal path, jI. Geometrically the same can be inferred from Figure 5, for a movement jk on ideal path; from isosceles triangles jak and jbI, $G_1=(ja+ak)/(jb+bI)=jk/jI=G_2$. Similarly for a movement along the line joining the position and origin, jO, both G_1 and G_2 are negative and equal.

Normalized-change in HDI in conjunction with path penalty appraises the progress in human development for countries. We illustrate this below.

Figure 4 Positive and negative zones of G_1 and G_2



Note: The shaded area corresponds to a zone where both G_1 and G_2 are positive. The hatched area corresponds to positive G_1 and negative G_2. The shaded cum hatched zone corresponds to negative G_1 and positive G_2 and the plain area corresponds to both G_1 and G_2 being negative.

6 Empirical illustration

By using comparable time series data obtained from Human Development Report Office the normalized-change in HDI is computed for 127 countries between the year 1990 and 2004. The countries are ranked both on the basis of G_1 and G_2. The difference in ranks indicates that a positive (negative) value implies a better (worse) performance of the country with HDI_2 compared with HDI_1. We also compute the normalized cumulative path penalty, ${}_{N}Q^{c}$, for the study period by combining the path penalties for 1990-95, 1995-2000, and 2000-04. Appendix 1 gives these values.[10]

6.1 Fall in HDI

Out of 127 countries under consideration, 111 countries show improvement in HDI from 1990 to 2004 both under HDI_1 and HDI_2. We refer to these countries as gainers. The rest 16 countries, which are referred as losers, are listed in Table 1. These countries in general are characterized by high path penalty, ${}_{N}Q^{c}$, indicating movement away from ideal path.

The five biggest losers, who have same ranks under G_1 and G_2, are all from Sub-Saharan region. Barring HDI_1 for Lesotho and South Africa for the period of 1990-95, these countries have experienced fall in HDI in all the three time periods viz. 1990-95, 1995-2000 and 2000-04. This fall is mostly attributed to poor health condition in the region, which is evident from the steep decline in life expectancy in the countries. The decline in health dimension has overtaken the improvements in other dimensions and made HDI to fall. For example, Botswana's life expectancy index, h, is 0.680, 0.569, 0.309 and 0.165 for 1990, 1995, 2000 and 2004 respectively. The corresponding education and income indices (e,y) are (0.679, 0.683), (0.718, 0.692), (0.744, 0.739) and (0.773, 0.768). The movement of Botswana is shown in Figure 5, in a two-dimensional HDI space (h,e). The widely deviated movement from ideal path has resulted in high penalty for Botswana (highest among 127 countries).

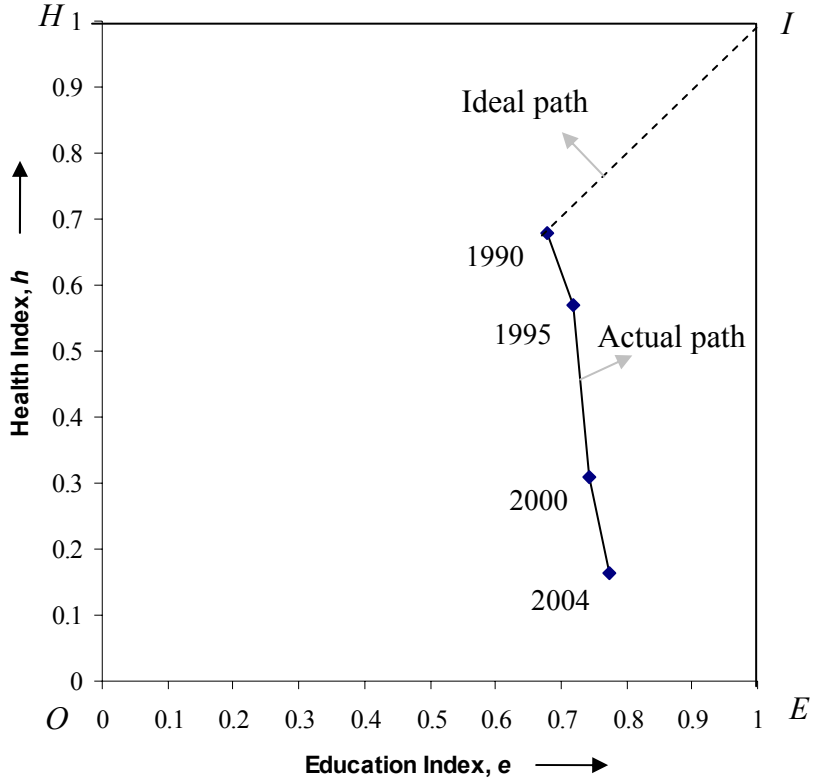
[10] In HDI_2 calculations, education index is computed using DI method between adult literacy and gross enrolment. The intermediate years 1995 and 2000 are chosen on the basis of availability of data.

Table 1: The losers

Country	HDI_1				HDI_2				G_1 (1990-2004)	G_1 Rank, R_1	G_2 (1990-2004)	G_2 Rank, R_2	Rank Diff (R_1-R_2)	${}_NQ^c$
	1990	1995	2000	2004	1990	1995	2000	2004						
Zimbabwe	0.639	0.591	0.525	0.494	0.630	0.564	0.477	0.439	-0.2263	127	-0.3035	127	0	0.0716
Swaziland	0.622	0.604	0.536	0.506	0.618	0.584	0.486	0.431	-0.1859	126	-0.3022	126	0	0.0745
Botswana	0.680	0.660	0.598	0.568	0.681	0.654	0.551	0.484	-0.1645	125	-0.2890	125	0	0.0842
Lesotho	0.572	0.573	0.524	0.501	0.560	0.560	0.487	0.441	-0.1251	124	-0.2122	124	0	0.0593
South Africa	0.735	0.741	0.691	0.662	0.723	0.717	0.658	0.603	-0.0991	123	-0.1653	123	0	0.0470
Zambia	0.464	0.425	0.409	0.437	0.452	0.404	0.382	0.399	-0.0587	120	-0.1166	122	-2	0.0300
Kenya	0.548	0.525	0.504	0.518	0.541	0.514	0.481	0.486	-0.0550	119	-0.1000	121	-2	0.0313
Moldova	0.740	0.683	0.679	0.696	0.714	0.637	0.627	0.648	-0.0592	121	-0.0923	120	1	0.0316
Tajikistan	0.697	0.631	0.627	0.652	0.657	0.571	0.567	0.598	-0.0646	122	-0.0899	119	3	0.0335
Ukraine	0.800	0.748	0.755	0.774	0.781	0.720	0.720	0.744	-0.0326	118	-0.0476	118	0	0.0279
Russian Federation	0.818	0.771	0.785	0.797	0.795	0.746	0.754	0.764	-0.0259	116	-0.0390	117	-1	0.0231
Côte d'Ivoire	0.443	0.428	0.427	0.430	0.442	0.430	0.429	0.431	-0.0309	117	-0.0244	116	1	0.0179
Cameroon	0.515	0.495	0.502	0.524	0.515	0.497	0.494	0.503	0.0189	113	-0.0235	115	-2	0.0232
Congo	0.528	0.533	0.502	0.525	0.509	0.515	0.488	0.502	-0.0060	115	-0.0140	114	1	0.0197
Tanzania	0.437	0.423	0.420	0.451	0.434	0.416	0.408	0.429	0.0260	112	-0.0104	113	-1	0.0225
Kazakhstan	0.768	0.723	0.736	0.774	0.741	0.691	0.703	0.735	0.0265	111	-0.0082	112	-1	0.0225

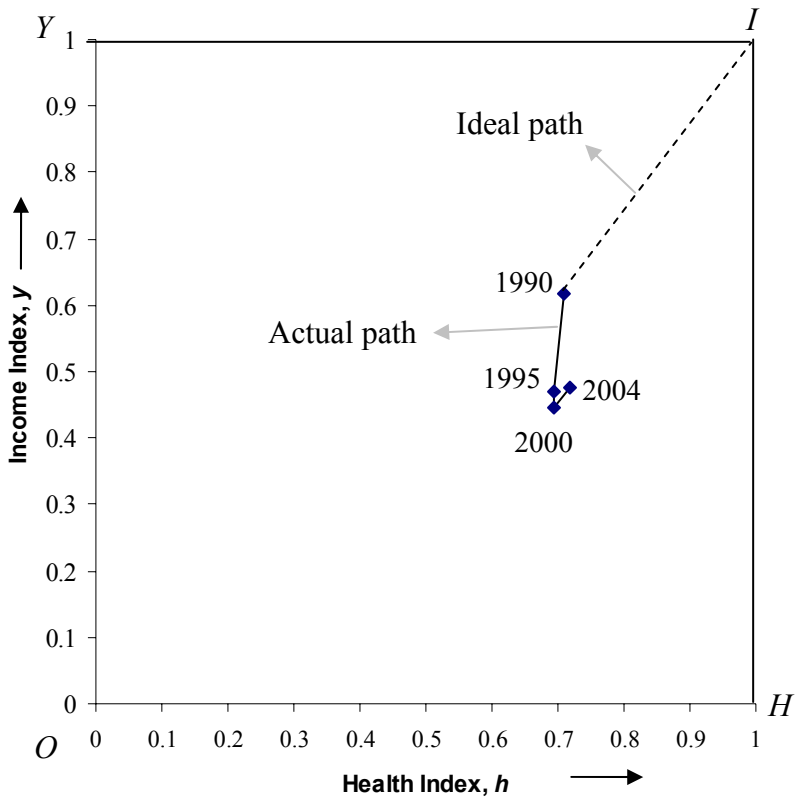
There are six more Sub-Saharan countries, other than the bottom five, which find place in the losers list. These countries are also characterized by low life expectancies. From the HDI values it is apparent that these countries are on the recovery path since 2000. This can be attributed to various recent global and local health initiatives in the region and the progresses in some countries thereof. For example, in Ethiopia, Malawi, Mozambique, Namibia, Niger, Rwanda and Tanzania the under-five mortality rates have declined by more than 20 percent between 2000 and 2004 (UNICEF, 2007). Also, the incidence and prevalence of HIV/AIDS has slowed down in the region (UNAIDS, 2008). The reforms in governance and distributive systems coupled with mechanism to safeguard people against risks have also been instrumental for progress in the region (Fosu and Mwabu, 2010). As per Global Monitoring Report (GMR), 2007, real per capita income growth in the region's low-income countries has been stronger since 2000 than in any period since the 1960s.

Figure 5 Movement of Botswana in HDI space (*h*,*e*), 1990-2004



The other countries in Table 1 are from Commonwealth of Independent States (CIS). One observes a decline in all the three dimensions of human development between 1990 and 1995, that is, the period immediately after the disintegration of the Soviet Union. This is largely on account of an economic collapse and fall in real outputs (Campos and Coricelli, 2002; World Bank, 2002; Linn, 2004). This gets reflected in the sharp decline in income indices for these countries. Since the late nineties all these countries have started a sustained recovery process (Linn, 2004), and this economic revival is attributed to political and macroeconomic stability, structural and institutional reform, upturn in agriculture, foreign direct investment (FDI) inflows among other reasons (Dowling and Wignaraja, 2005; International Monetary Fund (IMF), 2005; Dowling and Wignaraja, 2006).

Figure 6 Movement of Moldova in HDI space (*y*,*h*),1990-2004



The case of CIS can be illustrated by considering the case of Moldova. Its health, education and income indices (*h*,*e*,*y*) are (0.709,0.892,0.618), (0.695,0.886,0.469), (0.693,0.897,0.446) and (0.718,0.894,0.476) for 1990, 1995, 2000 and 2004 respectively,

which shows Moldova has steadied in health and education dimension in the study period after the initial hiccup. However, the income dimension has shown sharp decline till the second half of the nineties and is on the recovery since then. The movement of Moldova has been shown in Figure 6, in two-dimensional HDI space (y,h).

Among the 16 losers, G_1 is positive for three countries, namely, Cameroon, Tanzania and Kazakhstan. This is because, the algebraic sum of progress in three dimensions for these countries for the time period 1990-2004 turns out to be positive. However from the individual dimensions, it is seen that there is improvement in a better performing dimension and decline in a lower performing dimension, and hence, cannot substitute each other under HDI_2. For instance, Cameroon's health index fell from 0.465 to 0.344 whereas its education index rose from 0.561 to 0.713. The difference being larger in the later, HDI_1 is positive. But, health being the lower performing dimension the negative movement because of decline in health index turns out to be more than the positive movement on account of improvement in education dimension under HDI_2. This point is further substantiated by considering some cases from gainers.

6.2 Rise in HDI

Table 2 lists some of the gainers. The countries whose ranks differed under G_1 and G_2 are considered in pair wise fashion to highlight the contrast. In general, the countries which got lower rank as per G_2 than G_1 are characterized by high path penalty, ${}_{\mathrm{N}}Q^c$. Some of the selected countries movements from 1990 to 2004 have been shown in Figure 7 in the two dimensional HDI space (y,e).

The income index of Equatorial Guinea, a Sub-Saharan country, has more than doubled during 1990-2004. However the health dimension has suffered because of the regional characteristics of infant/child mortality, malnourishment, and HIV/AIDS infections. Compared to Equatorial Guinea, the northeastern African country of Sudan has moved in

health and income dimension in proportion to their respective shortfall, that is, along the ideal path (Figure 7). The movement away from ideal path for Equatorial Guinea is evident from its high normalized cumulative path penalty, Q^c, compared to that of Sudan.

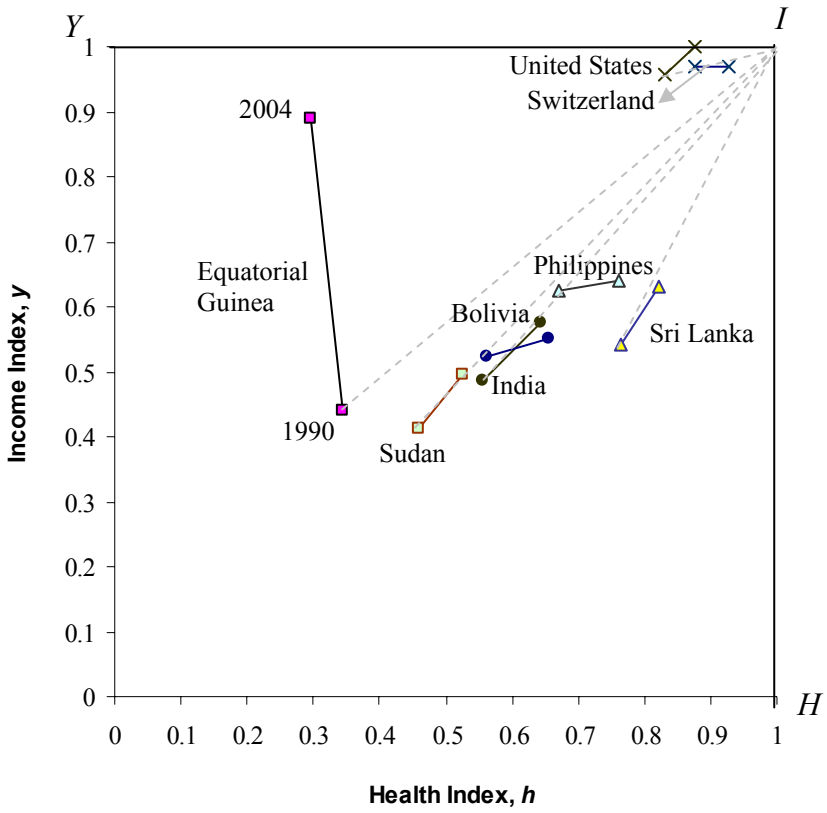
Table 2 Selected gainers - whose ranks differed as per G_1 and G_2

Country	HDI_1		HDI_2		G_1 (1990-2004)	G_1 Rank, R_1	G_2 (1990-2004)	G_2 Rank, R_2	Rank Diff (R_1-R_2)	${}_N Q^c$
	1990	2004	1990	2004						
Equatorial Guinea	0.501	0.652	0.477	0.569	0.3034	31	0.1764	68	-37	0.0300
Sudan	0.427	0.519	0.432	0.526	0.1609	80	0.1649	75	5	0.0013
Bolivia	0.605	0.694	0.598	0.666	0.2237	56	0.1687	73	-17	0.0046
India	0.515	0.609	0.513	0.608	0.1949	64	0.1946	60	4	0.0002
Jordan	0.685	0.765	0.685	0.747	0.2548	44	0.1966	58	-14	0.0065
Turkey	0.682	0.756	0.686	0.755	0.2324	52	0.2199	48	4	0.0017
United States	0.917	0.948	0.897	0.926	0.3749	23	0.2802	35	-12	0.0019
Switzerland	0.914	0.947	0.896	0.941	0.3844	21	0.4376	10	11	0.0006
Denmark	0.898	0.943	0.885	0.923	0.4378	15	0.3298	26	-11	0.0028
Austria	0.897	0.944	0.886	0.936	0.4541	11	0.4381	9	2	0.0008
Paraguay	0.721	0.759	0.715	0.742	0.1337	84	0.0945	94	-10	0.0049
Algeria	0.650	0.730	0.638	0.727	0.2281	54	0.2465	42	12	0.0030
Uruguay	0.806	0.851	0.792	0.831	0.2331	51	0.1911	61	-10	0.0033
Saudi Arabia	0.708	0.777	0.704	0.779	0.2367	50	0.2551	39	11	0.0008
Netherlands	0.913	0.947	0.905	0.933	0.3925	20	0.3021	29	-9	0.0037
Italy	0.890	0.940	0.879	0.936	0.4502	12	0.4726	7	5	0.0010
Philippines	0.722	0.770	0.703	0.745	0.1748	75	0.1411	79	-4	0.0028
Sri Lanka	0.706	0.759	0.685	0.742	0.1809	73	0.1802	64	9	0.0010
Bangladesh	0.422	0.533	0.419	0.518	0.1910	66	0.1705	72	-6	0.0023
Senegal	0.405	0.464	0.398	0.463	0.0991	99	0.1081	90	9	0.0020
United Kingdom	0.889	0.940	0.878	0.930	0.4555	10	0.4273	13	-3	0.0070
United Arab Emirates	0.810	0.842	0.790	0.827	0.1676	79	0.1788	67	12	0.0043

For Bolivia, the movement away from ideal path is characterized by a slower improvement in income dimension, compared to health. In comparison, India's movement almost coincides with the ideal path. In fact the normalized cumulative path penalty, Q^c, for India is lowest among all the 127 countries considered here. Similar observation can be made in case of comparison between Philippines and Sri Lanka, where the former has almost stagnated in income dimension, whereas the movement of the later is fairly close to the ideal path (Figure 7). Another set of countries Jordan and Turkey show similar characteristics. Both these countries start with almost same level of HDI in 1990; Jordan's progress in the

least performing income dimension is low compared to other dimensions. On the contrary, Turkey's progress has been closer to the ideal path.

Figure 7 Comparative movements of selected countries in HDI space (*y*,*h*),1990-2004



Note: The dashed line area the ideal paths for the countries considered. Since these countries are HDI gainers, that is, G is positive; the direction of movement is obvious (the time period is not marked for each country because of paucity of space).

The stagnancy in a higher performing dimension is less serious. This is evident from the movement of Switzerland vis-à-vis United States. Both these countries are characterised by high income. In 1990, the income index, *y*, for Switzerland and United States are 0.969 and 0.957 respectively. By 2004, *y* for United States was close to unity; whereas it had not changed for Switzerland. However, Switzerland has achieved more progress in health where it was relatively lower compared to its income dimension. United States could not achieve proportionate progress in health as the European countries because of its low life expectancy attributed to iniquitous health care system with relatively high ethnic diversity, income

inequality, infant mortality and mortality from violence among young adults among other reasons (Preston and Ho, 2009).

Progress in human development in terms of G_α is dominated by developed countries. The top 19 G_1 and 22 G_2 countries are from the top 30 countries of 1990 as per HDI_1 and HDI_2 respectively. This indicates the high human development countries reducing their shortfall from ideal at a faster rate compared to lower ranked countries. China is the only developing country to find a place in top 30 counties in terms of G_α. In the study period of 1990-2004, China grew at a rate of 8-9%, its GNP multiplied more than five folds, life expectancy increased by three years, infant mortality decreased by half and adult literacy rate went close to 90% from 77.7% (Baige, 2006). Other countries showing improvement are Rwanda, Oman, Tunisia, Iran, Vietnam and Cape Verde.

6.3 Fluctuation in HDI movement

The steadiness in movement in HDI space is assessed through the measure of fluctuation, *F*. Table 3 shows the list of countries with more than 50 per cent fluctuation. The first six in the list are CIS states. The decrease of all indices and particularly the sharp decline of income indices between 1990 and 1995, immediately after their formation following disintegration of the former Soviet Union, and their recent recovery explain this high fluctuation. The economic collapse has also had repercussion beyond the CIS countries, which is evident from depression in income index in the neighbouring countries like Mongolia, Bulgaria, Romania, Estonia and Croatia.

There are 15 countries which have fluctuations less than one per cent. These include five high human development countries like Japan, Oman, Mauritius, Panama and Saudi Arabia. These countries not only show low normalized cumulative penalty (${}_N Q^c \leq 0.001$), but also low fluctuations indicating that the sub periodic movements adhere to the ideal path. The medium development countries with similar behaviour are India, Pakistan, China and Tunisia.

Table 3 Countries experiencing maximum fluctuations

Country	Health Index, h				Education Index, e				Income Index, y				Q^c	min(Q^c)	F
	1990	1995	2000	2004	1990	1995	2000	2004	1990	1995	2000	2004			
Armenia	0.720	0.741	0.766	0.777	0.897	0.861	0.895	0.905	0.598	0.501	0.546	0.620	0.1194	0.0074	0.7629
Belarus	0.760	0.728	0.715	0.720	0.927	0.924	0.949	0.953	0.678	0.606	0.660	0.708	0.1084	0.0331	0.6807
Russian Federation	0.728	0.687	0.678	0.670	0.940	0.918	0.953	0.953	0.785	0.707	0.725	0.767	0.1384	0.0673	0.6616
Lithuania	0.761	0.752	0.776	0.792	0.908	0.897	0.953	0.966	0.805	0.718	0.761	0.814	0.1097	0.0209	0.6494
Kazakhstan	0.693	0.650	0.632	0.640	0.923	0.906	0.923	0.962	0.687	0.613	0.653	0.719	0.1351	0.0524	0.6406
Ukraine	0.728	0.695	0.689	0.685	0.918	0.908	0.942	0.944	0.756	0.641	0.634	0.694	0.1675	0.0848	0.6345
Bahamas	0.721	0.709	0.724	0.754	0.876	0.879	0.897	0.857	0.872	0.848	0.871	0.865	0.0654	0.0207	0.6284
Congo	0.493	0.443	0.435	0.455	0.697	0.724	0.681	0.738	0.393	0.431	0.391	0.381	0.1183	0.0487	0.6262
Latvia	0.731	0.725	0.761	0.781	0.904	0.892	0.942	0.960	0.774	0.690	0.743	0.794	0.0985	0.0147	0.6093
Bulgaria	0.770	0.766	0.775	0.790	0.891	0.886	0.919	0.928	0.722	0.698	0.697	0.733	0.0442	0.0074	0.5937
Mongolia	0.598	0.608	0.629	0.658	0.870	0.830	0.869	0.915	0.471	0.464	0.479	0.505	0.0654	0.0089	0.5290
Estonia	0.742	0.736	0.760	0.777	0.934	0.924	0.955	0.965	0.763	0.719	0.779	0.831	0.0591	0.0059	0.5134
Croatia	0.784	0.802	0.822	0.836	0.863	0.876	0.889	0.902	0.784	0.733	0.775	0.802	0.0444	0.0040	0.5093

7 Concluding remarks

There has been an increasing focus on broader measurements of human progress to capture wellbeing, happiness, security and sustainability. Amongst all these measures, HDI stands out as the most successful and widely accepted measure (UNU-WIDER, 2007). Inclusion of direct physical quality of life measures like health and education and consideration of income as an 'indirect' indicator to value person's command over resources make HDI a 'pragmatic', though not 'pure' measure of human development (Qizilbash, 2002).

In a background paper for HDR, Molina and Purser (2010) analyse trends in HDI for the last four decades and observe that there have been substantial improvements in human development without much correlation between income growth and the other dimensions. More often than not, it is the state interventions in health and education that are relevant.

The present paper is more about measurement of HDI and its change. The conventional measure is a simple linear averaging of the three dimensions, HDI_1. Under this, there is perfect substitutability across dimensions and a country with relatively higher income can get a higher value/rank even if health and education dimensions are not doing well. To address this, the current paper uses HDI_2 which is an inverse of the Euclidean distance measuring shortfall from the ideal. Such an approach as well as the associated measure of normalized-change, which satisfies certain axiomatic properties, penalizes countries that give greater emphasis to one dimension while neglecting the other dimensions. Given an initial level, the latter approach also indicates an ideal path and any deviation from this is indicated through path penalty. Further, the paper proposes a measure to capture fluctuations in the movement.

Our empirical exercise was carried for the time period 1990 to 2004. From 127 countries, 16 show movements away from ideal with incremental HDI being negative. It is not a mere coincidence that these countries are from Sub-Saharan and CIS regions. The Sub-

Saharan countries are plagued from poor health infrastructure coupled with HIV/AIDS. The sharp decline in life expectancy in the study period has led to a movement away from ideal path for some countries of the region. CIS countries experienced a negative shock, particularly in the income dimension during 1990-1995. However, the sub-periodic analysis shows that the countries are in recovery path since 2000. The CIS countries are also characterized by high fluctuations in their movement.

The progress in human development turns out to be faster for countries already high in human development. This is because the shortfall is low for these countries in absolute terms. Also, the analysis show emerging economies like China and India have shown larger progress in HDI and movement closer to the ideal path with low fluctuations. This study can further be extended to establish policy linkages.

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Appendix 1

Table A1 HDI under linear average and displaced ideal, measure of normalized-change, cumulative path penalty and measure of fluctuation

Country	HDI_1				HDI_2				G_1 (1990-2004)	G_1 Rank, R_1	G_2 (1990-2004)	G_2 Rank, R_2	Rank Diff (R_1-R_2)	${}_NQ^c$	F
	1990	1995	2000	2004	1990	1995	2000	2004							
Australia	0.893	0.933	0.947	0.957	0.885	0.919	0.936	0.949	0.5997	3	0.5537	1	2	0.0043	0.1809
Luxembourg	0.887	0.913	0.930	0.945	0.852	0.880	0.904	0.927	0.5167	5	0.5051	2	3	0.0015	0.0372
Iceland	0.916	0.921	0.945	0.960	0.909	0.916	0.940	0.955	0.5241	4	0.5044	3	1	0.0018	0.0996
Ireland	0.873	0.897	0.932	0.956	0.863	0.887	0.916	0.932	0.6521	1	0.5005	4	-3	0.0052	0.0412
Sweden	0.901	0.933	0.949	0.951	0.892	0.924	0.939	0.945	0.5050	6	0.4933	5	1	0.0053	0.2391
Korea, Rep. of	0.823	0.860	0.890	0.912	0.807	0.847	0.878	0.901	0.5044	7	0.4872	6	1	0.0007	0.0167
Italy	0.890	0.908	0.924	0.940	0.879	0.901	0.918	0.936	0.4502	12	0.4726	7	5	0.0010	0.0395
Norway	0.912	0.936	0.956	0.965	0.902	0.924	0.939	0.947	0.6057	2	0.4623	8	-6	0.0026	0.0439
Austria	0.897	0.916	0.937	0.944	0.886	0.907	0.927	0.936	0.4541	11	0.4381	9	2	0.0008	0.0574
Switzerland	0.914	0.925	0.941	0.947	0.896	0.914	0.934	0.941	0.3844	21	0.4376	10	11	0.0006	0.0375
New Zealand	0.876	0.906	0.925	0.936	0.867	0.895	0.912	0.924	0.4879	8	0.4336	11	-3	0.0024	0.0699
Hong Kong, China (SAR)	0.864	0.883	0.917	0.929	0.863	0.876	0.913	0.922	0.4802	9	0.4298	12	-3	0.0027	0.1343
United Kingdom	0.889	0.927	0.939	0.940	0.878	0.910	0.923	0.930	0.4555	10	0.4273	13	-3	0.0070	0.3621
Israel	0.867	0.890	0.918	0.924	0.868	0.890	0.918	0.924	0.4268	16	0.4220	14	2	0.0016	0.1087
Belgium	0.902	0.932	0.945	0.945	0.892	0.916	0.930	0.936	0.4383	14	0.4105	15	-1	0.0045	0.3280
Japan	0.914	0.927	0.939	0.949	0.906	0.921	0.934	0.945	0.4052	18	0.4101	16	2	0.0004	0.0079
Spain	0.893	0.910	0.927	0.938	0.885	0.902	0.920	0.931	0.4206	17	0.3969	17	0	0.0016	0.1089
France	0.904	0.923	0.935	0.942	0.897	0.916	0.929	0.937	0.3956	19	0.3891	18	1	0.0011	0.1092
Finland	0.904	0.917	0.938	0.947	0.891	0.902	0.922	0.933	0.4443	13	0.3865	19	-6	0.0025	0.2135
Oman	0.695	0.740	0.776	0.801	0.677	0.729	0.772	0.800	0.3474	27	0.3820	20	7	0.0010	0.0057
Cyprus	0.846	0.868	0.893	0.905	0.842	0.862	0.888	0.901	0.3817	22	0.3750	21	1	0.0006	0.0328
China	0.628	0.685	0.730	0.760	0.617	0.677	0.722	0.755	0.3548	25	0.3610	22	3	0.0007	0.0115
Malta	0.828	0.855	0.876	0.886	0.829	0.856	0.878	0.887	0.3404	29	0.3424	23	6	0.0023	0.1866
Greece	0.876	0.880	0.897	0.921	0.867	0.872	0.890	0.913	0.3624	24	0.3411	24	0	0.0025	0.0862

Contd.

Table A1 HDI under linear average and displaced ideal, measure of normalized-change, cumulative path penalty and measure of fluctuation

Country	HDI_1				HDI_2				G_1 (1990-2004)	G_1 Rank, R_1	G_2 (1990-2004)	G_2 Rank, R_2	Rank Diff (R_1-R_2)	${}_NQ^c$	F
	1990	1995	2000	2004	1990	1995	2000	2004							
Portugal	0.853	0.883	0.902	0.904	0.843	0.869	0.891	0.896	0.3478	26	0.3381	25	1	0.0051	0.2865
Denmark	0.898	0.913	0.932	0.943	0.885	0.898	0.914	0.923	0.4378	15	0.3298	26	-11	0.0028	0.0476
Chile	0.787	0.818	0.843	0.861	0.775	0.809	0.833	0.849	0.3457	28	0.3294	27	1	0.0008	0.0405
Tunisia	0.659	0.700	0.739	0.762	0.653	0.693	0.735	0.760	0.3033	32	0.3067	28	4	0.0010	0.0134
Netherlands	0.913	0.932	0.944	0.947	0.905	0.918	0.929	0.933	0.3925	20	0.3021	29	-9	0.0037	0.2342
Iran, Islamic Rep. of	0.651	0.695	0.723	0.753	0.650	0.695	0.725	0.754	0.2901	35	0.2968	30	5	0.0012	0.0093
Lebanon	0.682	0.729	0.748	0.777	0.666	0.722	0.736	0.765	0.2996	34	0.2959	31	3	0.0019	0.0888
Malaysia	0.723	0.761	0.791	0.806	0.726	0.764	0.792	0.806	0.3003	33	0.2934	32	1	0.0009	0.0271
Bahrain	0.812	0.828	0.842	0.866	0.809	0.826	0.842	0.864	0.2867	36	0.2878	33	3	0.0011	0.0916
Hungary	0.811	0.815	0.845	0.869	0.795	0.800	0.831	0.854	0.3071	30	0.2861	34	-4	0.0036	0.1558
United States	0.917	0.930	0.940	0.948	0.897	0.909	0.919	0.926	0.3749	23	0.2802	35	-12	0.0019	0.1260
Mauritius	0.726	0.749	0.779	0.803	0.730	0.753	0.782	0.806	0.2828	38	0.2797	36	2	0.0005	0.0084
Poland	0.807	0.820	0.848	0.862	0.789	0.802	0.832	0.848	0.2833	37	0.2769	37	0	0.0009	0.0657
Cape Verde	0.628	0.679	0.711	0.725	0.630	0.677	0.710	0.726	0.2620	41	0.2598	38	3	0.0012	0.0249
Saudi Arabia	0.708	0.742	0.765	0.777	0.704	0.741	0.766	0.779	0.2367	50	0.2551	39	11	0.0008	0.0043
Samoa (Western)	0.700	0.742	0.765	0.778	0.672	0.720	0.742	0.755	0.2605	42	0.2536	40	2	0.0008	0.0463
Argentina	0.813	0.835	0.860	0.863	0.802	0.826	0.846	0.851	0.2688	39	0.2486	41	-2	0.0028	0.2169
Algeria	0.650	0.672	0.701	0.730	0.638	0.666	0.698	0.727	0.2281	54	0.2465	42	12	0.0030	0.0291
Thailand	0.717	0.751	0.775	0.792	0.708	0.742	0.761	0.779	0.2638	40	0.2444	43	-3	0.0057	0.2145
Viet Nam	0.618	0.661	0.696	0.716	0.592	0.632	0.667	0.691	0.2551	43	0.2420	44	-1	0.0010	0.0427
Mexico	0.766	0.784	0.811	0.823	0.767	0.783	0.809	0.819	0.2461	46	0.2255	45	1	0.0020	0.0710
Brazil	0.720	0.749	0.785	0.792	0.721	0.747	0.773	0.784	0.2544	45	0.2246	46	-1	0.0026	0.0416
Costa Rica	0.793	0.812	0.832	0.844	0.781	0.800	0.820	0.830	0.2448	47	0.2228	47	0	0.0015	0.1179
Turkey	0.682	0.713	0.743	0.756	0.686	0.716	0.743	0.755	0.2324	52	0.2199	48	4	0.0017	0.0428
Panama	0.751	0.774	0.797	0.811	0.743	0.765	0.786	0.799	0.2401	48	0.2191	49	-1	0.0006	0.0051
Estonia	0.813	0.793	0.831	0.858	0.793	0.771	0.809	0.837	0.2399	49	0.2141	50	-1	0.0098	0.5134
El Salvador	0.651	0.690	0.715	0.731	0.655	0.692	0.715	0.728	0.2278	55	0.2125	51	4	0.0020	0.0405

Contd

Table A1 HDI under linear average and displaced ideal, measure of normalized-change, cumulative path penalty and measure of fluctuation

Country	HDI_1				HDI_2				G_1 (1990-2004)	G_1 Rank, R_1	G_2 (1990-2004)	G_2 Rank, R_2	Rank Diff (R_1-R_2)	${}_NQ^c$	F
	1990	1995	2000	2004	1990	1995	2000	2004							
Egypt	0.580	0.613	0.654	0.673	0.566	0.598	0.637	0.657	0.2218	58	0.2110	52	6	0.0017	0.0140
Guatemala	0.586	0.617	0.656	0.678	0.591	0.623	0.658	0.678	0.2219	57	0.2110	53	4	0.0022	0.0094
Peru	0.708	0.735	0.760	0.775	0.697	0.725	0.742	0.757	0.2286	53	0.2008	54	-1	0.0016	0.0537
Morocco	0.549	0.580	0.610	0.641	0.534	0.566	0.598	0.628	0.2029	63	0.2004	55	8	0.0020	0.0288
Indonesia	0.626	0.665	0.682	0.708	0.620	0.659	0.673	0.695	0.2184	60	0.1975	56	4	0.0018	0.0614
Colombia	0.730	0.754	0.775	0.790	0.728	0.751	0.769	0.782	0.2216	59	0.1973	57	2	0.0026	0.0306
Jordan	0.685	0.710	0.744	0.765	0.685	0.706	0.729	0.747	0.2548	44	0.1966	58	-14	0.0065	0.0737
Dominican Republic	0.682	0.703	0.733	0.747	0.683	0.703	0.732	0.745	0.2051	62	0.1960	59	3	0.0011	0.0272
India	0.515	0.548	0.577	0.609	0.513	0.546	0.577	0.608	0.1949	64	0.1946	60	4	0.0002	0.0075
Uruguay	0.806	0.819	0.841	0.851	0.792	0.807	0.825	0.831	0.2331	51	0.1911	61	-10	0.0033	0.1861
Rwanda	0.339	0.337	0.426	0.465	0.323	0.307	0.414	0.451	0.1900	67	0.1881	62	5	0.0161	0.3098
Latvia	0.803	0.769	0.815	0.845	0.785	0.748	0.794	0.824	0.2145	61	0.1816	63	-2	0.0164	0.6093
Sri Lanka	0.706	0.729	0.747	0.759	0.685	0.708	0.729	0.742	0.1809	73	0.1802	64	9	0.0010	0.0317
Albania	0.704	0.704	0.738	0.759	0.694	0.692	0.727	0.749	0.1854	69	0.1798	65	4	0.0030	0.2182
Syrian Arab Republic	0.646	0.673	0.690	0.712	0.638	0.669	0.685	0.703	0.1858	68	0.1789	66	2	0.0026	0.0659
United Arab Emirates	0.810	0.819	0.833	0.842	0.790	0.806	0.822	0.827	0.1676	79	0.1788	67	12	0.0043	0.0814
Equatorial Guinea	0.501	0.519	0.643	0.652	0.477	0.495	0.579	0.569	0.3034	31	0.1764	68	-37	0.0300	0.0344
Lao People's Dem. Rep.	0.451	0.488	0.523	0.551	0.450	0.486	0.521	0.547	0.1827	72	0.1764	69	3	0.0007	0.0028
Croatia	0.810	0.803	0.828	0.847	0.801	0.790	0.817	0.836	0.1921	65	0.1758	70	-5	0.0074	0.5093
Nepal	0.425	0.467	0.500	0.522	0.409	0.452	0.488	0.512	0.1686	78	0.1731	71	7	0.0019	0.0088
Bangladesh	0.422	0.454	0.510	0.533	0.419	0.449	0.495	0.518	0.1910	66	0.1705	72	-6	0.0023	0.0401
Bolivia	0.605	0.637	0.675	0.694	0.598	0.626	0.652	0.666	0.2237	56	0.1687	73	-17	0.0046	0.0102
Yemen	0.394	0.438	0.467	0.497	0.384	0.429	0.459	0.486	0.1702	76	0.1661	74	2	0.0033	0.0105
Sudan	0.427	0.465	0.496	0.519	0.432	0.471	0.504	0.526	0.1609	80	0.1649	75	5	0.0013	0.0307

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Table A1 HDI under linear average and displaced ideal, measure of normalized-change, cumulative path penalty and measure of fluctuation

Country	HDI_1				HDI_2				G_1 (1990-2004)	G_1 Rank, R_1	G_2 (1990-2004)	G_2 Rank, R_2	Rank Diff (R_1-R_2)	${}_NQ^c$	F
	1990	1995	2000	2004	1990	1995	2000	2004							
Belize	0.748	0.770	0.780	0.794	0.737	0.758	0.769	0.779	0.1832	71	0.1610	76	-5	0.0045	0.1530
Nicaragua	0.610	0.642	0.667	0.679	0.611	0.639	0.661	0.672	0.1767	74	0.1560	77	-3	0.0020	0.0099
Lithuania	0.825	0.789	0.830	0.857	0.810	0.771	0.808	0.837	0.1840	70	0.1422	78	-8	0.0183	0.6494
Philippines	0.722	0.738	0.759	0.770	0.703	0.716	0.734	0.745	0.1748	75	0.1411	79	-4	0.0028	0.0389
Uganda	0.411	0.413	0.474	0.510	0.412	0.409	0.455	0.494	0.1691	77	0.1398	80	-3	0.0122	0.2779
Pakistan	0.463	0.493	0.511	0.532	0.457	0.487	0.507	0.529	0.1284	86	0.1326	81	5	0.0005	0.0076
Romania	0.775	0.770	0.778	0.808	0.761	0.754	0.760	0.792	0.1480	81	0.1309	82	-1	0.0042	0.3858
Chad	0.335	0.344	0.357	0.420	0.334	0.347	0.361	0.420	0.1283	87	0.1284	83	4	0.0134	0.2089
Guyana	0.684	0.687	0.716	0.730	0.657	0.658	0.683	0.699	0.1467	82	0.1218	84	-2	0.0040	0.2377
Papua New Guinea	0.481	0.514	0.530	0.544	0.488	0.520	0.535	0.549	0.1213	90	0.1201	85	5	0.0026	0.1388
Honduras	0.625	0.642	0.654	0.677	0.624	0.640	0.650	0.668	0.1410	83	0.1187	86	-3	0.0033	0.0197
Mauritania	0.390	0.425	0.447	0.465	0.391	0.424	0.445	0.463	0.1237	89	0.1177	87	2	0.0011	0.0537
Benin	0.372	0.397	0.416	0.444	0.365	0.391	0.414	0.439	0.1150	92	0.1170	88	4	0.0038	0.0094
Ghana	0.511	0.531	0.555	0.572	0.515	0.536	0.557	0.571	0.1245	88	0.1162	89	-1	0.0037	0.0098
Senegal	0.405	0.422	0.439	0.464	0.398	0.418	0.438	0.463	0.0991	99	0.1081	90	9	0.0020	0.0414
Mongolia	0.646	0.634	0.659	0.693	0.606	0.597	0.619	0.647	0.1306	85	0.1048	91	-6	0.0109	0.5290
Mozambique	0.316	0.330	0.364	0.395	0.319	0.335	0.365	0.389	0.1154	91	0.1030	92	-1	0.0075	0.0412
Mali	0.285	0.309	0.332	0.359	0.283	0.306	0.329	0.355	0.1034	97	0.1002	93	4	0.0015	0.0295
Paraguay	0.721	0.740	0.754	0.759	0.715	0.732	0.740	0.742	0.1337	84	0.0945	94	-10	0.0049	0.0931
Armenia	0.738	0.701	0.736	0.767	0.709	0.661	0.696	0.737	0.1094	93	0.0941	95	-2	0.0199	0.7629
Comoros	0.506	0.521	0.539	0.557	0.512	0.525	0.542	0.557	0.1034	98	0.0920	96	2	0.0052	0.0177
Ethiopia	0.314	0.322	0.349	0.377	0.316	0.327	0.353	0.379	0.0921	100	0.0918	97	3	0.0056	0.0473
Madagascar	0.448	0.459	0.482	0.507	0.450	0.460	0.480	0.496	0.1074	96	0.0838	98	-2	0.0083	0.0829
Bulgaria	0.794	0.783	0.797	0.817	0.780	0.766	0.775	0.798	0.1092	94	0.0805	99	-5	0.0074	0.5937
Burkina Faso	0.308	0.312	0.330	0.355	0.300	0.307	0.327	0.352	0.0678	104	0.0747	100	4	0.0039	0.1310
Venezuela	0.760	0.768	0.774	0.786	0.755	0.763	0.764	0.772	0.1083	95	0.0704	101	-6	0.0044	0.2976
Trinidad and Tobago	0.793	0.791	0.801	0.810	0.780	0.777	0.787	0.796	0.0790	102	0.0686	102	0	0.0065	0.0685

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Table A1 HDI under linear average and displaced ideal, measure of normalized-change, cumulative path penalty and measure of fluctuation

Country	HDI_1				HDI_2				G_1 (1990-2004)	G_1 Rank, R_1	G_2 (1990-2004)	G_2 Rank, R_2	Rank Diff (R_1-R_2)	${}_NQ^c$	F
	1990	1995	2000	2004	1990	1995	2000	2004							
Guinea-Bissau	0.313	0.341	0.353	0.357	0.312	0.340	0.354	0.359	0.0639	105	0.0684	103	2	0.0085	0.0489
Niger	0.246	0.254	0.268	0.287	0.238	0.249	0.264	0.283	0.0544	106	0.0581	104	2	0.0036	0.0556
Nigeria	0.407	0.419	0.433	0.454	0.405	0.414	0.421	0.438	0.0782	103	0.0562	105	-2	0.0132	0.0473
Jamaica	0.719	0.725	0.737	0.743	0.713	0.718	0.724	0.729	0.0861	101	0.0535	106	-5	0.0057	0.0364
Togo	0.498	0.507	0.504	0.515	0.491	0.501	0.503	0.514	0.0347	108	0.0440	107	1	0.0120	0.0496
Bahamas	0.823	0.812	0.831	0.826	0.808	0.797	0.814	0.814	0.0139	114	0.0299	108	6	0.0109	0.6284
Burundi	0.351	0.325	0.344	0.370	0.353	0.331	0.347	0.370	0.0287	109	0.0266	109	0	0.0150	0.2368
Belarus	0.788	0.753	0.775	0.794	0.762	0.718	0.742	0.764	0.0269	110	0.0094	110	0	0.0181	0.6807
Malawi	0.372	0.414	0.398	0.399	0.371	0.386	0.373	0.374	0.0425	107	0.0061	111	-4	0.0178	0.0572
Kazakhstan	0.768	0.723	0.736	0.774	0.741	0.691	0.703	0.735	0.0265	111	-0.0082	112	-1	0.0225	0.6406
Tanzania, U. Rep. of	0.437	0.423	0.420	0.451	0.434	0.416	0.408	0.429	0.0260	112	-0.0104	113	-1	0.0225	0.1156
Congo	0.528	0.533	0.502	0.525	0.509	0.515	0.488	0.502	-0.0060	115	-0.0140	114	1	0.0197	0.6262
Cameroon	0.515	0.495	0.502	0.524	0.515	0.497	0.494	0.503	0.0189	113	-0.0235	115	-2	0.0232	0.0974
Côte d'Ivoire	0.443	0.428	0.427	0.430	0.442	0.430	0.429	0.431	-0.0309	117	-0.0244	116	1	0.0179	0.0470
Russian Federation	0.818	0.771	0.785	0.797	0.795	0.746	0.754	0.764	-0.0259	116	-0.0390	117	-1	0.0231	0.6616
Ukraine	0.800	0.748	0.755	0.774	0.781	0.720	0.720	0.744	-0.0326	118	-0.0476	118	0	0.0279	0.6345
Tajikistan	0.697	0.631	0.627	0.652	0.657	0.571	0.567	0.598	-0.0646	122	-0.0899	119	3	0.0335	0.4858
Moldova, Rep. of	0.740	0.683	0.679	0.696	0.714	0.637	0.627	0.648	-0.0592	121	-0.0923	120	1	0.0316	0.3327
Kenya	0.548	0.525	0.504	0.518	0.541	0.514	0.481	0.486	-0.0550	119	-0.1000	121	-2	0.0313	0.0850
Zambia	0.464	0.425	0.409	0.437	0.452	0.404	0.382	0.399	-0.0587	120	-0.1166	122	-2	0.0300	0.2298
South Africa	0.735	0.741	0.691	0.662	0.723	0.717	0.658	0.603	-0.0991	123	-0.1653	123	0	0.0470	0.0972
Lesotho	0.572	0.573	0.524	0.501	0.560	0.560	0.487	0.441	-0.1251	124	-0.2122	124	0	0.0593	0.0190
Botswana	0.680	0.660	0.598	0.568	0.681	0.654	0.551	0.484	-0.1645	125	-0.2890	125	0	0.0842	0.0054
Swaziland	0.622	0.604	0.536	0.506	0.618	0.584	0.486	0.431	-0.1859	126	-0.3022	126	0	0.0745	0.0165
Zimbabwe	0.639	0.591	0.525	0.494	0.630	0.564	0.477	0.439	-0.2263	127	-0.3035	127	0	0.0716	0.0439

HDI_1 and HDI_2 are Human Development Index (HDI) under linear average and displaced ideal respectively and G_1 and G_1 are their respective measure of normalized-change.