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Human Assets Index retrospective series: 2016 update

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Introduction

Human capital, a broad concept including education and health, is considered as an essential driver of development patterns and human well-being. Undernourishment, poor health and low education attainment remain considerable obstacles to economic and social progress in Developing Countries (DCs) and particularly in the Least Developed Countries (LDCs). The Millenium Development Goals adopted by the United Nations in September 2000, where five of the eight Goals relate to education or health, portray the outstanding importance of human development. This importance has been renewed with the adoption of the Sustainable Development Goals in September 2015 that maintain the goals of "zero hunger", "good health and well-being" and "quality education".

.../...

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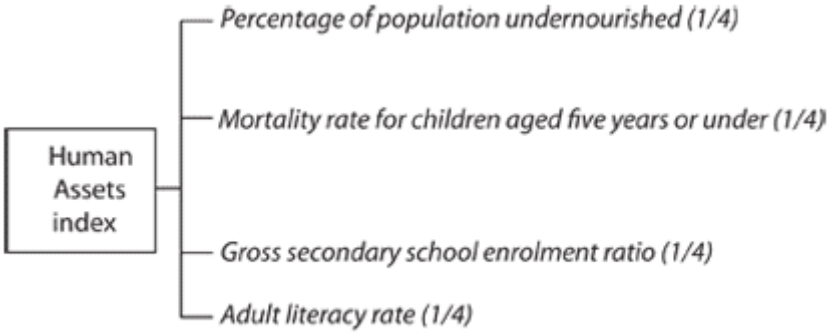
…/… Low human capital became one of the three criteria used by the United Nations Committee for Development Policy (UN-CDP) for identifying Least Developed Countries (LDCs).[1] Since 1991, the UN-CDP has used a composite index to measure human capital at the country level. In 2003 this index was reshaped and was renamed "Human Assets Index" (HAI).

As shown in Figure 1, the HAI is a composite indicator which combines four indicators, two indicators of health and nutrition outcomes (Percentage of the population undernourished, Mortality rate for children aged five years or under) and two indicators of education (Gross secondary school enrolment ratio, Adult literacy rate).

Figure 1. The Human Assets Index and its four components



Numbers in parenthesis indicate the weight in the overall HAI.

Source: UN-CDP

The primary data for each variable are rescaled and converted into index values using a max-min procedure. The HAI is then calculated as the simple average of the four components indices. Each component carries an equal weight of 25 % in the HAI and the normalized scores vary between 0 and 100.

Every three years, the UN-CDP computes and publishes the HAI for the triennial reviews of the LDCs. Since the 2006 review, the overall methodology and the four components of the index have remained unchanged. While the bounds used in the max-min procedure were readjusted in 2009 and 2012 by the UN-CDP following changes in the extreme values observed, they remained unchanged for the 2015 review. Table 1 shows the bounds used in the three last reviews by the UN-CDP.

[1] The two other criteria are the GNI per capita and the Economic Vulnerability Index. See Guillaumont (2009) and UN-DESA-DPAD-CDP webpage on LDCs: http://www.un.org/en/development/desa/policy/cdp/index.shtml

Table 1. Changes in the bounds used in the min-max procedure

	2009 Review Bounds		2012 Review Bounds		2015 Review Bounds	
Components	Min	Max	Min	Max	Min	Max
Undernourishment	2.5	65	5	65	5	65
Under Five Mortality	10	240	10	175	10	175
Secondary School Enrolment	5.7	100	10	100	10	100
Literacy rate	15	100	25	100	25	100

Source: UN-CDP

Even if these methodological changes remain marginal, the analysis of trends in human capital requires the calculation of retrospective series with a constant definition over time and time series that are updated and comparable over time. This was done previously for the HAI by the Ferdi after the 2009 Review (Korachais, 2011) and the 2012 Review (Closset, Feindouno, Goujon, 2014)[2]. Retrospective series of the HAI have been used by, among others, Guillaumont (2009, 2011, 2013, 2015), Guillaumont and Wagner (2012), Guillaumont, MacGillivray and Wagner (2013), Wagner (2014), Kaya (2016), and Gnangnon (2016).

The construction of retrospective series for the HAI pursues the same aim and follows the same principles than the ones for the Economic Vulnerability Index (see Cariolle and Goujon, 2013, Feindouno and Goujon, 2016). The construction of retrospective series faces various challenges. The main one is historical data availability, which is especially weak for some components and some developing countries. Unlike the Economic Vulnerability Index (which is based on economic statistics), most of components of the HAI are based on social statistics which are characterized by their scarcity. Accordingly, Korachais (2011) and Closset, Feindouno, Goujon (2014) distinguished two sets of retrospectives series, the "HAI FOS" (From Official Sources), designed from official but uncompleted statistics; and the "HAI WFG" (With Filled Gaps) which expands the country/year coverage using econometric tools to generate missing data.

Here, due to improved data coverage in recent years, and because we restrict the computation from the year 1990, this distinction of two datasets is no longer relevant. We then present only one set of retrospective series, for which, to a limited extent, we have used econometric tools to consistently impute missing data.[3] [4] While "HAI WFG" series from Closset et al (2014) were made

[2] The FERDI background paper on the retrospective HAI and the associated database are referenced on the UNDP-DESA-DPAD LDC data retrieval webpage. The CDP points out that "the FERDI data is meant for analytical purposes only. Due to differences in methodologies, data sources and data revisions, the FERDI historical time series may differ from the data used by the CDP and its secretariat in the triennial reviews of the list of the LDCs."
http://www.un.org/en/development/desa/policy/cdp/ldc/ldc_data.shtml
More recently, the UN-CDP has opened StatPlanet Graphical Interface, a visual and retrieval tool for 2006, 2009, 2012 and 2015 data.

[3] In a small number of cases, we were not able to use imputation methods. Due to missing data on some components, HAI is missing over some years for Solomon Islands (1990-1991); Palau and Federated States of Micronesia (1990-1992); Marshall Islands (1990-1994); Tuvalu (1990-2000); Nauru (1990-2005). Only one year is available for DPR of Korea (2009) and Turkmenistan (2014) and HAI is missing over the entire period for Singapore and South Sudan.

available for about 130 developing countries over 1970-2011, the updated retrospective series of the HAI presented here cover 145 developing countries over 1990-2014.

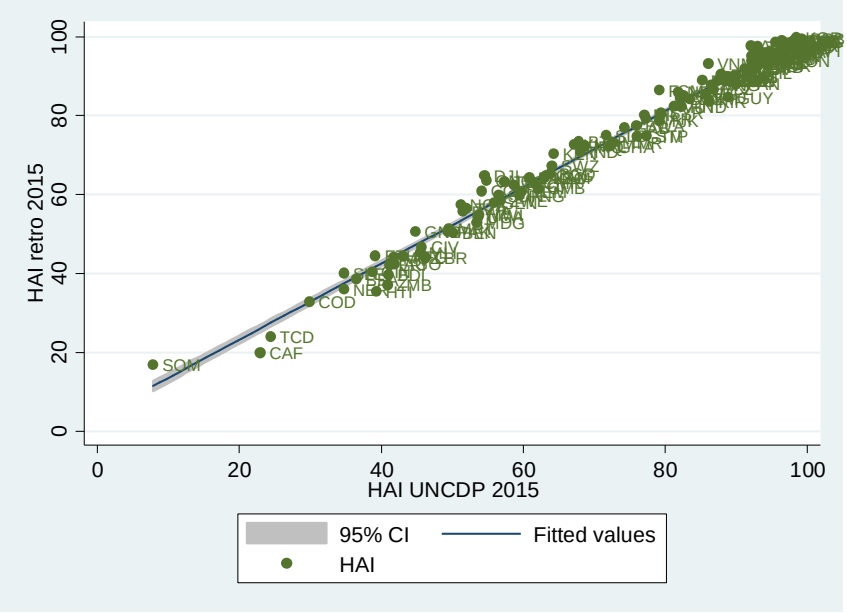
In this document, we detail the methods used to set up the retrospective series of the HAI. The first section presents some general results from the HAI retrospective series, the second section details the calculation method for each component of the HAI.

1. Human Asset Index retrospective series

1.1 Comparison between UN-CDP and retrospective HAI scores

As a first relevance check, we compare the scores of the official UN-CDP HAI released at the triennial review of 2015 with the scores of our retrospective HAI for the year 2013 (this corresponds to the year of the data used by the UN-CDP review 2015). Figure 2 shows a high correlation (98.5%) between the scores of both HAI (of 141 countries, excluding DPR Korea, Singapore, South Sudan, Turkmenistan due to missing data). One can observe small differences between UN-CDP and retrospective series of HAI scores. This is the case when the UN-CDP used information from different reports that may not correspond to the year 2013 while we preferably use econometric models to generate data that correspond to every year. Also, our calculations have been done some months after the UN-CDP's ones and can make use of primary data further updated, then creating some other discrepancies.

Figure 2. Correlation between HAI scores of the UN-CDP 2015 Review and the retrospective 2015 HAI database for the year 2013.



[4] Since series are completed with generated values from econometric estimates using explanatory variables such as the GNI per capita or the Gini coefficient, we advise using them for econometric analysis cautiously.

1.2 Evolution of the retrospective HAI scores: LDCs versus Non-LDCs

Figure 3 shows the evolution of the HAI scores over the period 1990-2014 for 135 countries (45 LDCs and 90 non-LDCs[5]). The average score of HAI is significantly higher in Non-LDCs than in LDCs. However, since 2000, the slope of the LDCs HAI curve has steepened, substantially reducing the gap with the Non-LDCs. As reported in Table 2, the gap between LDCs and non-LDCs is on average about 46 points in 1990 (HAI score in LDCs is 24.7 versus 70.3 in Non-LDCs); 37 points in 2010 (48.5 in LDCs versus 85.9 in Non-LDCs); and 34 points in 2014 (54.1 in LDCs versus 88.1 in Non-LDCs).

However, HAI scores in LDCs present a high level of standard deviation, signaling heterogeneity within this group. The level of HAI in African LDCs is lower than in Non-African LDCs, and increases less rapidly between 2000 and 2014 (+20 points for African LDCs versus +24 points for Non-African LDCs). Countries that show the greatest progress in the LDCs group between 2000 and 2014 are: Rwanda (+39), Timor-Leste (+36 points), Senegal (+34 points), Djibouti (+34 points), Ethiopia (+33 points), and Cambodia (+32 points). On the other hand, no or weak progresses are recorded in Central African Republic (+1 point), Lesotho (+7 points), Kiribati (+8 points), Haiti (+8 points). Relative to their initial level of HAI in 1990, Timor-Leste (+57 points), Bhutan (+48 points), Djibouti (+45 points), Ethiopia (+45 points), Bangladesh (+43 points), Lao PDR (+43 points) have made the greatest strides.

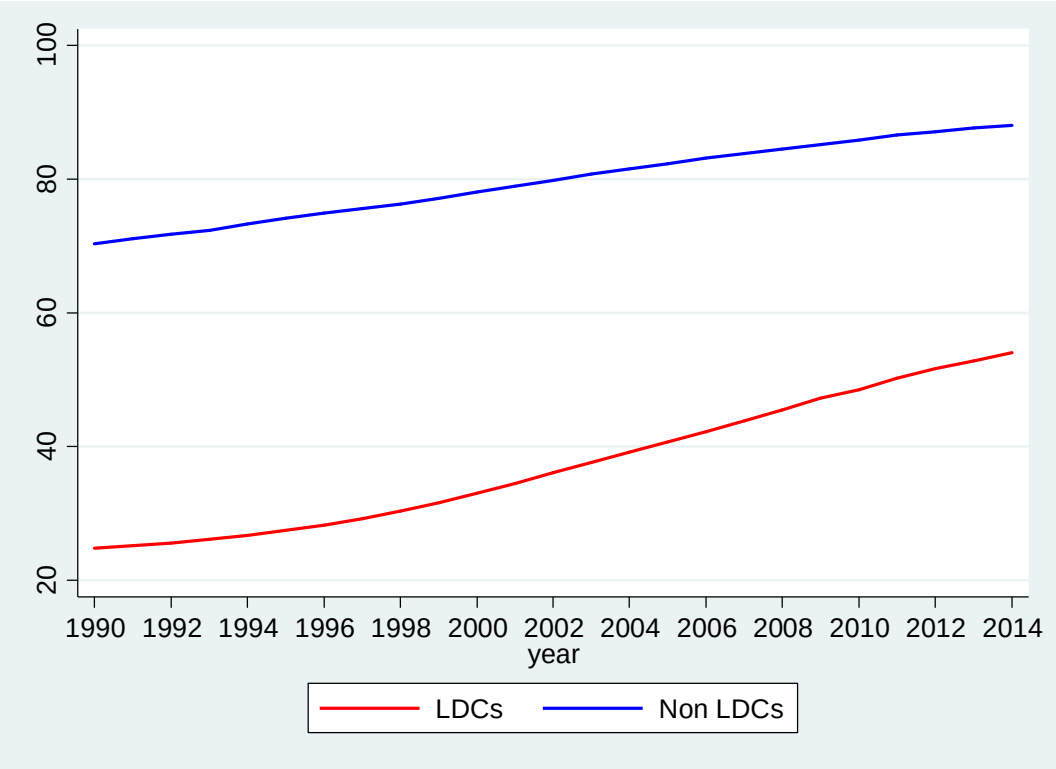
Table 2. HAI average scores by country groups

Country groups	1990	2000	2010	2014
LDCs	24.7 *(14.7)*	33.0 *(15.7)*	48.5 *(15.9)*	54.1 *(15.9)*
Non-LDCs	70.3 *(16.5)*	78.1 *(15.7)*	85.9 *(13.0)*	88.1 *(11.8)*
African LDCs	22.8 *(14.2)*	28.6 *(13.3)*	43.5 *(12.9)*	48.7 *(13.6)*
Non-African LDCs	29.6 *(15.5)*	43.7 *(16.4)*	60.7 *(16.3)*	67.2 *(13.8)*

Note: Standard deviations are indicated in brackets under the means.

[5] . To get a constant sample over time, we remove 10 countries for which data are not complete over the entire period (see footnote 3): Marshall Islands, Tuvalu, Nauru, Turkmenistan, Palau, Solomon Islands, Singapore, Federated States of Micronesia, South Sudan, DPR of Korea.

Figure 3. Changes in the retrospective HAI, LDCs versus non-LDCs averages



2. Health and nutrition components

The World Health Organization defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". Health promotes human development and is associated to economic prosperity, and permits individuals to fully develop their capacities. Hunger and malnutrition make people vulnerable to infectious disease, strongly influences their health and lower their productivity. Health indicators produced by the World Health Organization and other UN bodies include infant and child mortality rates, life expectancy, morbidity data, burden of disease, and so on. For capturing health and nutrition in the HAI, the UNCDP uses two components, the Percentage of population undernourished and the Mortality rate for children aged five years or under.

2.1 Percentage of population undernourished

2.1.1 Definition

The percentage of population undernourished is computed and regularly reported by the Food and Agriculture Organization of the United Nations (FAO). It estimates the proportion of the population with a calorie intake below the minimum necessary for an active and healthy life. The FAO uses the cutoff of 1800 calories as the average minimum energy requirement per person per

day[6].

2.1.2 Calculation principles of the Undernourishment index retrospective series

Primary data on the prevalence of undernourishment is retrieved from the official dataset FAOSTAT (data available at http://faostat3.fao.org/home/E). Over the period 1990-2014, data are more complete than two years ago, and most of the methods applied in Closset, Feindouno and Goujon (2014) are no longer required.

Data are complete over all the 25 years except for 28 countries for which there is no information available on undernourishment, which represent 19% of the sample[7]. To deal with this, we resort to econometric regressions to predict undernourishment prevalence from available information on strong correlates, income distribution measured by the Gini index, and gross national income per capita (GNIpc). The depth of the food deficit / the mean level of dietary energy consumption (kilocalories per person per day) that has been used in Closset et al (2014) is no longer useful because this variable and the prevalence of undernourishment has now the same country/year coverage.

Method 1: using GNIpc, GINI and region fixed effects

This method (former method 4 of Closset et al, 2014) is used to impute missing data on undernourishment to countries with complete series on GNIpc and GINI. The first step consists in estimating the following OLS regression on the sample of countries/years for which undernourishment, GNIpc and GINI data are available, which also exploit region fixed effects:

$$U_{1it} = \alpha_1 + \beta_1 * \ln(GNIpc_{it}) + \gamma_1 * \ln(Gini_{it}) + \delta_1 * t_t + \mu_{1i} * region + \varepsilon_{1it}$$

With:

U : undernourishment, FAO primary data

GNIpc : Gross national income per capita, World Development Indicators - World Bank

Gini: Gini index, World Development Indicators – The World Bank.

region: a set of dummies Middle East and North Africa (MENA), Sub Saharan Africa (SSA), South Asia (SA), East Asia and Pacific (EAP), Latin America and Caribbean (LAC) and Europe and Central Asia (ECA).

[6] The exact requirement is determined by a person's age, body size, activity level and physiological conditions such as illness, infection, pregnancy and lactation. Therefore, many nutritionists set a cutoff of 2100 calories as the minimum energy requirement per person per day to maintain a healthy, active lifestyle.

[7] Antigua and Barbuda, Burundi, Bahrain, Bahamas, Bhutan, Democratic Republic of the Congo, Comoros, Dominica, Eritrea, Federated States of Micronesia, Equatorial Guinea, Grenada, Saint Kitts and Nevis, Libya, Saint Lucia, Marshall Islands, Nauru, Palau, Papua New Guinea, Qatar, Sudan, Singapore, Somalia, South Sudan, Seychelles, Syria, Tonga, Tuvalu.

Coefficient are taken out and used to calculate values for countries where data on U are missing but data on GNIpc and GINI are available:

$$\widehat{U_{1it}} = \hat{\alpha}_1 + \hat{\beta}_1 * \ln(GNIpc_{it}) + \hat{\gamma}_1 * \ln(Gini_{it}) + \hat{\delta}_1 * t_t + \hat{\mu}_{1i} * region$$

Data have been generated using this method for Burundi, Comoros, Democratic Republic of Congo, Papua New Guinea, Federated States of Micronesia (for the 1993-2014 period), Saint Lucia, Seychelles, Syria (1990-2007) and Sudan (2008-2014).

Method 2: using GNI and region fixed effects

This method (former method 5 of Closset et al, 2014) is used to impute missing data on undernourishment to countries (-years) for which only series on GNIpc are available. The first step consists in estimating the following OLS regression:

$$U_{2it} = \alpha_2 + \beta_2 * \ln(GNIpc_{it}) + \delta_2 * t_t + \mu_{2i} * region + \varepsilon_{2it}$$

Coefficient are taken out and used to calculate missing values:

$$\widehat{U_{2it}} = \hat{\alpha}_2 + \hat{\beta}_2 * \ln(GNIpc_{it}) + \hat{\delta}_2 * t_t + \hat{\mu}_{2i} * region$$

This Method 2 has been used to produce data for Antigua and Barbuda, Bhutan, Dominica, Equatorial Guinea, Eritrea (for the 1994-2011 period), Grenada, Libya (2001-2014), Marshall Island (1995-2014), Palau (1993-2014), Saint Kitts and Nevis, South Sudan (2010-2014), Tonga and Tuvalu (2001-2014).

Special cases

For some countries, the use of methods 1 and 2 is not possible because data on GINI and GNIpc are missing. Thus:

- Data for Somalia are obtained from the 2012 retrospective series of Undernourishment; and extrapolated on 2012-2014.
- Former Sudan data prior to 2008 are used for Sudan and South Sudan;
- Data for Nauru are obtained from the source indicated by the UN-CDP (from Statistics for Development Division-Secretariat of the Pacific Community: http://www.spc.int/nmdi/poverty).

After the use of these imputation methods, only 27 data are still missing, representing 0.7% of the sample of 145 countries over 1990-2014: Marshall Islands (1990-1994), Federated States of Micronesia (1990-1992), Nauru (1990-2005), and Palau (1990-1992).

2.1.3 Normalization and Bounds

Undernourishment, which is negatively related to human assets, is normalized through the following inversed formula (the higher the undernourishment, the lower the index):

$$U_{Index} = \begin{cases} 100 * \dfrac{Max - x}{Max - min} & if\ min < x < max \\ 0 & if\ x > Max \\ 100 & if\ x < min \end{cases}$$

With x is the country/year undernourishment prevalence value

Lower bound (Min): 5 Upper bound (Max): 65

2.1.4 Evolution of the retrospective Undernourishment index scores: LDCs versus Non-LDCs

The average index of undernourishment in LDCs has increased (the prevalence of undernourishment has decreased) steadily, from about 50 in 1990 to 70 in 2014.[8] The Figure 4 shows that the gap between LDCs and Non-LDCs has decreased over time from 30 in 1990 to 21 in 2014 with a clear relative improvement for LDCs over the 1998-2008 period. The decrease in the index (increase in the prevalence) of undernourishment at the beginning the 1990s is generally attributed to natural disasters such as drought, but also political instability, which brought about hunger and malnutrition, particularly in LDCs. The average figures, however, mask disparities across LDCs. This is reflected in Table 3 by higher standard deviations in LDCs compared to those observed in the Non-LDCs group. The level of undernourishment prevalence is higher in African LDCs than in Non-African LDCs. Also, it decreases more quickly in Non-African LDCs.

In LDCs, since 2000, the most impressive progress are achieved by Myanmar (+58 points), Angola (+57 points), Djibouti (+55 points), Ethiopia (+38 points), Rwanda (+37 points). However, some countries show deterioration compared to 2000: Somalia (–14 points), Central African Republic (–7 points), Zambia (–4 points), Burundi (–3 points).

[8] Again, we here retain only countries for which data on undernourishment index are available for all years. Nauru, Palau, Marshall Islands and Federated States of Micronesia are then excluded.

Figure 4. Changes in the Undernourishment index, LDCs versus non-LDCs averages

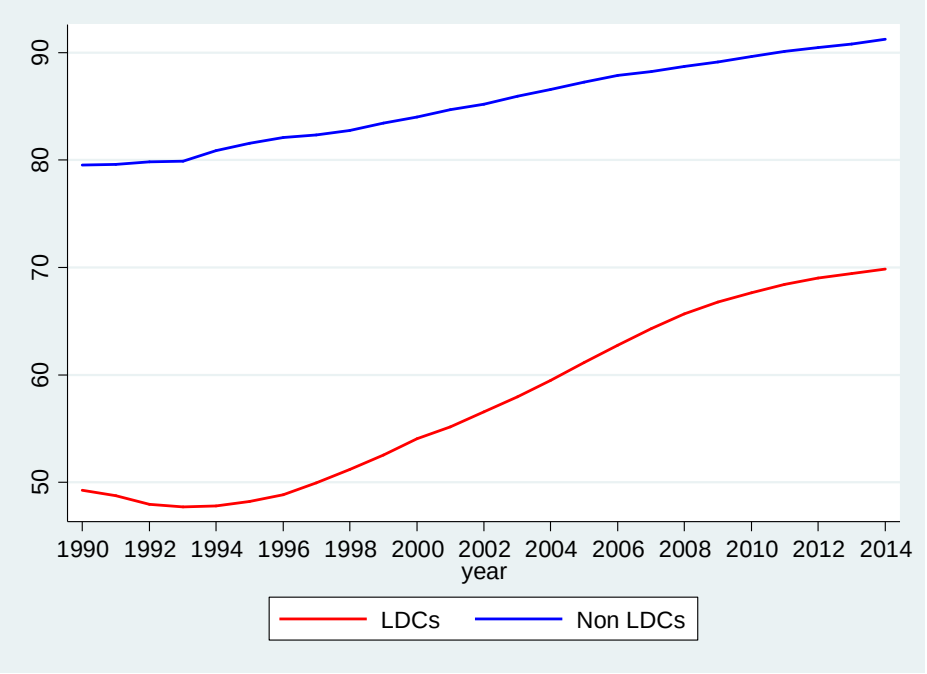


Table 3. Undernourishment index average scores by country groups

Country groups	1990	2000	2010	2014
LDCs	49.3 *(28.6)*	54.0 *(25.8)*	67.6 *(26.0)*	69.8 *(26.8)*
Non-LDCs	79.5 *(21.1)*	84.0 *(17.5)*	89.6 *(14.3)*	91.2 *(13.7)*
African LDCs	47.8 *(27.8)*	51.6 *(25.1)*	63.3 *(27.8)*	65.7 *(28.6)*
Non-African LDCs	52.6 *(30.8)*	59.4 *(27.3)*	77.1 *(19.0)*	78.8 *(20.3)*

Notes: Standard deviations are indicated in brackets under the means

2.2 Under-five mortality index

2.2.1 Definition

As explained in UN-DESA definitions, the Under-5 mortality rate "expresses the probability of dying between birth and age five. It is expressed as deaths per 1,000 births". The under-five mortality rate provides comprehensive information on the health impact of social, economic and environmental conditions in a country. It is influenced by poverty, education; by the availability, accessibility and quality of health services; by environmental risks including access to safe water and sanitation; and by nutrition.

Following the UN-CDP, we use the under-five mortality rate from the United Nations Inter-agency Group for Child Mortality Estimation (CME), CME Info, available from http://childmortality.org.[9]

2.2.2 Calculation principles of the Under-five mortality index retrospective series

The estimates of Under-five mortality rates from the United Nations - CME are now generated with a regression model for assessing levels and trends for all countries in the world over a long time period (Alkema and New, 2014). Thus, primary data on under-five mortality rates are now fully complete over 1990-2015, contrarily to that it was two years ago. Consequently interpolation and data generation methods that Closset et al (2014) used at that time are no longer necessary.

2.2.3 Normalization and Bounds

The Under-five mortality rate, which is negatively related to human assets, is normalized so as to get the index to enter the HAI through the following inversed formula (the higher the under-five mortality rate, the lower the index):

$$U5M_{Index} = \begin{cases} 100 * \dfrac{Max - x}{Max - min} & if\ min < x < max \\ 0 & if\ \ x > Max \\ 100 & if\ x < min \end{cases}$$

With x under-five mortality rate value.

Lower bound (Min): 10 Upper bound (Max): 175

2.2.4 Evolution of the retrospective Under-five mortality index scores: LDCs versus Non-LDCs

There has been a significant improvement in socio-economic and sanitary conditions in DCs over the last decades. However, the average under-five mortality is still higher (and accordingly the average Under-five mortality index is lower) in LDCs than in Non-LDCs despite a substantial relative progress, in particular since 2000. In LDCs, the average score increases from 17 in 1990 to 28 in 2000 and to 60 in 2014 while in Non-LDCs, it increases from 74 in 1990 to 80 in 2000 and to 90 in 2014, reducing the gap from 57 points in 1990 to 52 points in 2000, then to 30 points in 2014.

There are significant disparities within the group of LDCs. For instance, the average index score is considerably higher in Non-African LDCs than in African LDCs. But it appears from Table 4 that a faster improvement occurred in African LDCs between 2000 and 2014, which gained about 38 points versus 22 for Non-African LDCs. The greatest strides since 2000 in LDCs have been made by Rwanda (+79 points), Malawi (+65 points), Liberia (+61 points), Zambia (+58 points), Uganda (+55 points). In contrast, the lowest progresses are registered in Vanuatu (+0.2 point), Solomon Islands

[9] In the last version of HAI, these data were retrieved from the United Nations' World Population Prospects database http://esa.un.org/unpd/wpp/index.htm and http://data.un.org.

(+3 points) and Mauritania (+15 points).

Figure 5. Changes in the Under-five mortality index, LDCs versus non-LDCs averages

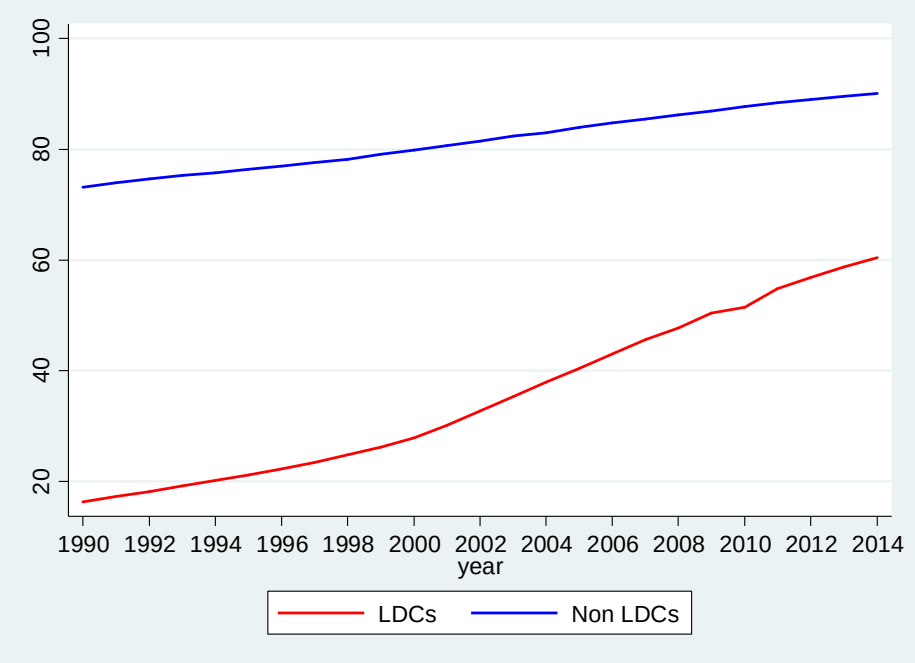


Table 4. Under-five mortality index average scores by country groups

Country groups	1990	2000	2010	2014
LDCs	16.3 *(22.3)*	27.8 *(25.4)*	51.4 *(23.2)*	60.5 *(19.7)*
Non-LDCs	73.2 *(21.2)*	79.8 *(21.0)*	87.7 *(14.8)*	90.1 *(12.4)*
African LDCs	8.2 *(13.9)*	15.8 *(17.7)*	44.1 *(19.7)*	53.3 *(18.3)*
Non-African LDCs	34.2 *(27.0)*	54.3 *(18.9)*	67.7 *(22.4)*	76.3 *(11.9)*

Notes: Standard deviations are indicated in brackets under the means

3. Education components

Education plays a crucial role in economic development. Regarded as a powerful tool for social and living standards progress, education also contributes to the reduction of economic inequalities through the dissemination of knowledge. The United Nations Educational, Scientific and Cultural Organization (UNESCO) collects data on various types of educational indicators such as enrolment numbers and rates, repetition rates, literacy rates, education stocks, average years of schooling, and so on. Education components of the HAI consist in two variables: adult literacy rate and gross secondary school enrolment ratio. The first relates to outputs (the direct results of the education process), and the latter to inputs (investments in education in terms of resources and time).

3.1 Adult literacy rate index

3.1.1 Definition

As defined by the UN-DESA, the adult literacy rate "measures the number of literate persons aged fifteen and above expressed as a percentage of the total population in that age group. A person is considered literate if he/she can read and write, with understanding, a simple statement related to his/her daily life"[10]. The indicator shows the accumulated achievement of primary education and literacy programs in imparting basic literacy skills to the population, thereby enabling them to apply such skills in life, contributing to the economic and socio-cultural development.

The adult literacy rate is regularly reported by the UNESCO Institute for Statistics at http://www.uis.unesco.org/.

3.1.2 Calculation principles of the Adult literacy index retrospective series

Despite significant improvement in terms of data coverage for the last two years, a large number of missing data still exist in the adult literacy rate database provided by the UNESCO Institute for Statistics. For our sample of 145 countries over 1990-2014, 3160 data out of 3625 are missing (about 87%). We first resort to simple linear interpolation and extrapolation to estimate data for countries where intermediate, beginning or end-of period data are scarcely missing (no more than 5 missing data). After this step, 992 missing data remain (about 27%), as the interpolation method is not relevant for 18 countries for which data are widely missing. We then rely on econometric methods of imputation.

Method 1: using GNI and country fixed effects

This method (former method 2 of Closset et al, 2014) is used for countries for which data on LR exist but are too scarce to use simple inter or extrapolation. It is based on a regression that links Literacy rate to GNI per capita, time and country fixed effects (using the within estimator):

$$LR_{1it} = \alpha_1 + \beta_1 * \ln(GNIpc_{it}) + \delta_1 * t_t + \mu_{1i} + \varepsilon_{1it}$$

With $GNIpc$: Gross national income per capita, World Development Indicators

Literacy rate is then generated by:

$$\widehat{LR_{1it}} = \hat{\alpha}_1 + \hat{\beta}_1 * \ln(GNIpc_{it}) + \hat{\delta}_1 * t_t + \hat{\mu}_{1i}$$

This method is used to generate data for Solomon Islands over 1992-2014.

[10] "Literacy" also encompasses "numeracy", the ability to make simple arithmetic calculations (Source: UNESCO Institute for Statistics glossary).

Method 2: using GNIpc and region fixed effects

This method (former method 3 of Closset et al 2014) is used for countries which have only one observation over the period 1990-2014. For these countries, it is not relevant to run country fixed-effects estimates using within estimator. Therefore, we introduce region fixed effects and provide estimates using OLS estimator:

$$LR_{2it} = \alpha_2 + \beta_2 * \ln(GNIpc_{it}) + \delta_2 * t_t + \mu_{2i} * Region_i + \varepsilon_{2it}$$

With:

$GNIpc$: Gross national income per capita, World Development Indicators- World Bank

$Region$: dummies Middle East and North Africa (MENA), Sub Saharan Africa (SSA), South Asia (SA), East Asia and Pacific (EAP), Latin America and Caribbean (LAC) and Europe and Central Asia (ECA)

The predicted value for Literacy rate is then:

$$\widehat{LR_{2it}} = \widehat{\alpha_2} + \widehat{\beta_2} * \ln(GNIpc_{it}) + \widehat{\delta_2} * t_t + \widehat{\mu_{2i}} * Region^i$$

This method is used to generate data for Djibouti over 1992-2005, and over the entire period for Bahamas, Barbados, Dominica, Fiji, Grenada, Israel, Kiribati, Marshall Islands, Federated States of Micronesia, Korea Republic, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines and Tuvalu.

Special cases

Due to incomplete data on GNIpc, both imputation methods are not applicable for a couple of countries:

- For Somalia, we use data from the last previous retrospective series;
- To complete data for Djibouti (2006-2014), we use data from the last previous retrospective series; and extrapolated over 2012-2014.

After the use of these imputation methods, only 20 data are still missing, representing 0,6% of the sample of 145 countries over 1990-2014: Marshall Islands (1990-1994), Federated States of Micronesia (1990-1991), Solomon Islands (1990-1991), Tuvalu (1990-2000).

3.1.3 Normalization and Bounds

The Adult literacy rate, which is positively related to human assets, is normalized using the following min-max formula (the higher the literacy rate, the higher the index; the literacy index is merely the adult literacy rate multiplied by 100):

$$LR_{Index} = \begin{cases} 100 * \dfrac{x - min}{Max - min} & if\ min < x < max \\ 100 & if\ x > Max \\ 0 & if\ x < min \end{cases}$$

With x Adult literacy rate value.

Lower bound (Min): 25 Upper bound (Max): 100

3.1.4 Evolution of the retrospective Adult literacy rate index scores: LDCs versus Non-LDCs

The gap between LDCs and Non-LDCs average Adult literacy index has remained large over time: it equals to 46 points in 1990, 44 points in 2000, 42 points in 2010, and 39 points in 2014. Compared to the two health and nutrition components of the HAI, progress in Adult literacy is very slower signaling an expected high degree of inertia despite efforts of developing countries' authorities and of the international community (e.g. the United Nations Literacy Decade launched in 2003 and the inclusion of "Education for all" in the Millenium Development Goals).

As shown by high standard deviations, the Adult literacy index is heterogeneous across the LDCs group. The average score is clearly lower in African LDCs than in Non-African LDCs since 2000 although the two groups had almost the same level in 1990. The Adult literacy rate index increased by 31 points in Non-African LDCs over 1990-2014 while the progress was much more modest in African LDCs with an increase of 17 points over the same period.

Considering only the LDCs over 2000-2014, the greatest progresses are achieved by Timor-Leste (+40 points), Burundi (+35 points), Eritrea (+32 points), Yemen (+29 points), and Gambia (+23 points) while others experienced setbacks, e.g. Central African Republic (–19 points), Sao Tome and Principe (–13 points), Lesotho (–10 points), and Madagascar (–8 points), Democratic Republic of the Congo (–4 points).

Figure 6. Changes in the Adult literacy rate index, LDCs versus non-LDCs averages

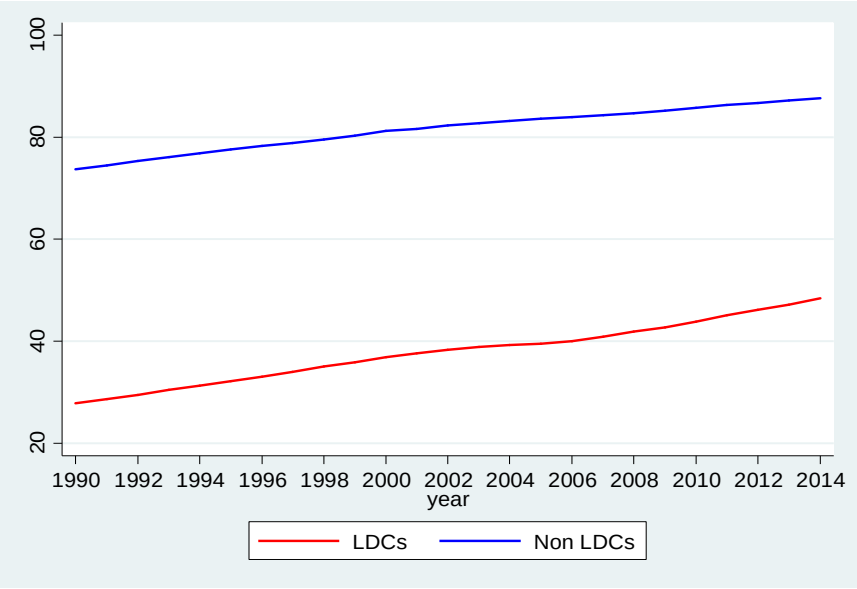


Table 5. Adult literacy rate index average scores by country groups

Country groups	1990	2000	2010	2014
LDCs	27.8 *(27.4)*	36.8 *(26.5)*	43.8 *(25.1)*	48.5 *(24.5)*
Non-LDCs	73.7 *(21.1)*	81.2 *(17.2)*	85.8 *(15.2)*	87.7 *(14.1)*
African LDCs	26.8 *(28.2)*	33.8 *(26.5)*	39.1 *(24.9)*	43.3 *(24.3)*
Non-African LDCs	30.3 *(26.1)*	44.4 *(25.9)*	55.7 *(22.2)*	61.5 *(20.5)*

Notes: Standard deviations are indicated in brackets under the means

3.2 Gross secondary school enrolment ratio index

3.2.1 Definition

The secondary education, which is one of the greatest challenges in poor countries, is usually measured by the gross secondary school enrolment ratio. As defined by the UNDP-DESA-DPAD, this indicator "measures the number of pupils enrolled in secondary schools, regardless of age, expressed as a percentage of the population in the theoretical age group for the same level of education"[11]. It provides information on the share of population with the level of skills deemed to be necessary for development. The indicator is regularly reported by the United Nations

[11] A high secondary enrolment rate generally indicates a high degree of participation, whether the pupils belong to the official age group or not. A rate approaching or exceeding 100% indicates that a country is, in principle, able to accommodate all of its school-age population, but it does not indicate the proportion already enrolled. The gross enrolment rate can exceed 100% due to the inclusion of over-aged and under-aged pupils because of early or late entrants, and grade repetition (Source: UNESCO Institute for Statistics glossary).

Educational, Scientific and Cultural Organization (UNESCO), Institute for Statistics (available at http://www.uis.unesco.org).

3.2.2 Calculation principles for the retrospective series of the Gross secondary enrolment ratio index

The raw data downloaded from the UNESCO website are missing for 1406 observations out of 3625 (39%). For intermediate and end-of period missing data, when no more than 5 data are missing, we use linear interpolation and extrapolation to fill them. After this step, 511 missing data remain (14%). For the other cases, we use imputation based on econometric regression.

Method 1: beginning of period, using GNIpc and country fixed effects

This method (former method 2 of Closset et al, 2014) is used for values missing at the beginning of the series. We use the following model which includes income level, one year lead value of gross secondary school enrolment ratio, and time and country fixed effects. The Within estimator is used:

$$SE_{1it} = \alpha_1 + \beta_1 * \ln(GNIpc_{it}) + \gamma_1 SE_{i,t+1} + \delta_1 * t_t + \mu_{1i} + \varepsilon_{1it}$$

The gross secondary school enrolment ratio is then generated, anti-chronologically and year after year:

$$\widehat{SE_{1it}} = \hat{\alpha}_1 + \hat{\beta}_1 * \ln(GNIpc_{it}) + \hat{\gamma}_1 SE_{i,t+1} + \hat{\delta}_1 * t_t + \hat{\mu}_{1i}$$

This method has been used sporadically to generate data for some countries, but more widely for Equatorial Guinea (2006-2014); Gabon (2003-2014); Cambodia (2009-2014); Bahrain (2007-2014); Guinea-Bissau (2007-2014); Haiti (1990-2014; Kiribati (2009-2014); Palau (1990-2002), Nauru (1990-1999); Federated States of Micronesia (2006-2014); Marshall Islands (1990-1998;2010-2014); Libya (2007-2014); Maldives (2005-2014); Timor-Leste(1990-2000); Trinidad and Tobago (2005-2014); Tuvalu (1990-2000); United Arab Emirates (2000-2014).

Special cases

Due to missing data on SE and GNIpc, data remain missing for the entire period for Singapore, South Sudan, Turkmenistan (except the year 2014), and Democratic People's Republic of Korea (except for the year 2009). This represents 98 data or 2.7% of the sample.

3.2.3 Normalization and Bounds

The gross secondary school enrolment ratio, which is positively related to human assets, is normalized using the following min-max formula (the higher the gross secondary school enrolment ratio, the higher the index):

$$SE_{Index} = \begin{cases} 100 * \dfrac{x - min}{Max - min} & if\ Min < x < max \\ 100 & if\ x > Max \\ 0 & if\ x < min \end{cases}$$

With x Gross secondary school enrolment ratio value.

Lower bound (Min): 10 Upper bound (Max): 100

3.2.4 Evolution of the retrospective gross secondary school enrolment ratio index scores: LDCs versus Non-LDCs

The secondary enrolment index is higher in LDCs than in Non-LDCs and the difference between the two groups has not declined significantly since 1990 (a gap of 47 points in 1990 versus 44 in 2014). Despite a real improvement, the secondary enrolment index remains very low in LDCs (39 versus 84 in Non-LDCs for the year 2014) and the index is even lower for the group of African LDCs.

Figure 7. Changes in the secondary enrolment index, LDCs versus non-LDCs averages

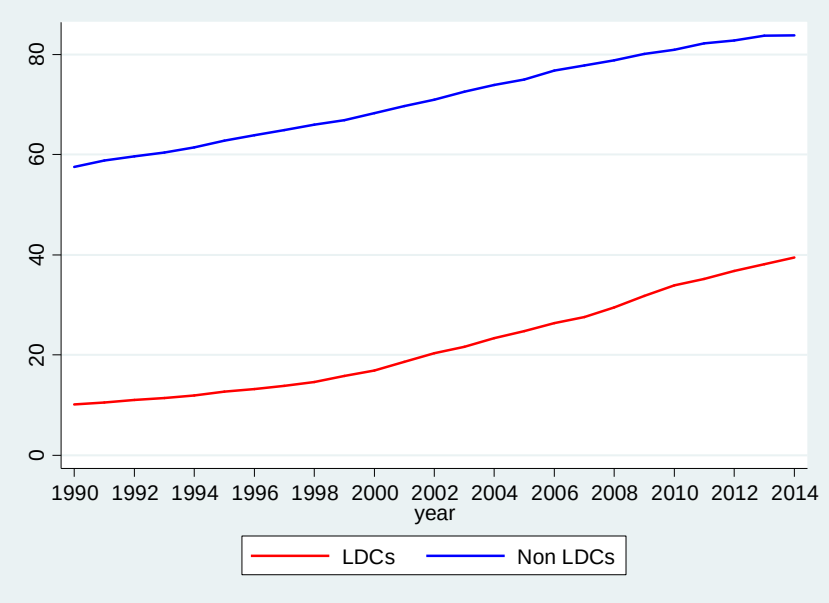


Table 6 shows that in 2014, the LDCs' average score is still lower, while Non-African LDCs' score is almost the same, than the one of Non-LDCs in 1990. Some LDCs progress rapidly since 2000, including Bhutan (+59 points), Cambodia (+48 points), Timor-Leste (+47 points), Afghanistan (+45 points), and Sao Tome and Principe (+44 points). The worst performers are Zambia (–3 points), Somalia (+0), Liberia (+3 points), Central African Republic (+ 6 points), Yemen (+ 8 points), and Niger (+10 points).

Table 6 also reports large standard deviations for both groups. Heterogeneity in African LDCs is lower than in non-African LDCs but tends to increase over time.

Table 6. Secondary enrolment index average scores by country groups

Country groups	1990	2000	2010	2014
LDCs	10.1 *(13.1)*	16.9 *(15.9)*	33.8 *(18.5)*	39.4 *(20.5)*
Non-LDCs	57.4 *(26.1)*	68.2 *(23.3)*	80.9 *(18.7)*	83.7 *(18.2)*
African LDCs	7.6 *(8.7)*	11.8 *(10.4)*	26.5 *(13.8)*	31.4 *(16.5)*
Non-African LDCs	15.3 *(18.8)*	27.7 *(20.2)*	49.3 *(17.8)*	56.6 *(17.8)*

Notes: Standard deviations are indicated in brackets under the means

4. Inside the HAI

Previous sections show that the four components of the HAI have different patterns of levels, distribution and trends[12]. We now explore different questions thanks to the use of retrospective series over 1990-2014. The first one is whether all of the 4 components evenly contribute to the progress in HAI, which is observed in DCs on average. Second, whether the HAI and components' distributions follow the same trend over time, signaling convergence or divergence between countries. Third, we compare the progress in health and education and their correlation over time within the group of developing countries.

4.1 Relative contribution of components to the average change in HAI, DCs and LDCs

We compute the average contribution of the 4 components to HAI change between 1990 and 2014 for 134 DCs of which 48 LDCs. It is equal to the change in component multiplied by 0.25. Contributions are reported for the change in HAI average for the DCs and LDCs groups in Table 7. Regarding DCs, the four components contribute to the average HAI increase. The Health and Education dimensions have a similar contribution but that is rather pushed by the under-five mortality index and the secondary enrolment index respectively.

Regarding the group of LDCs, the higher progress in HAI is explained by higher increases in the four components, but more significantly from Under-five mortality index.

[12] With in mind that these relative patterns between the four components are, above all, conditional to the linear functional form and values of the min and max bounds used in the normalization formula to build the components indices, as fixed by the UN-CDP.

Table 7. Contribution of components to change in HAI average

Index and Components	1990	2014	change	Contribution	in percent
Developing countries					
HAI	55.1	76.8	21.7	21.7	100.0
Undernourishment	68.7	84.0	15.3	3.8	17.5
Under5mortality	53.3	80.1	26.8	6.7	30.9
Literacy	57.8	74.5	16.7	4.2	19.4
SecondaryEnroll	40.6	68.4	27.8	7.0	32.2
Least developed countries					
HAI	24.7	54.1	29.4	29.4	100.0
Undernourishment	47.7	68.9	21.2	5.3	18.0
Under5mortality	14.0	59.5	45.5	**11.4**	**38.8**
Literacy	28.4	49.3	20.9	5.2	17.7
SecondaryEnroll	8.8	38.5	29.7	7.5	25.5

Notes: Component's contribution to HAI change = 25% × change in component.

Constant sample of 135 DCs o.w. 45 LDCs over 1990-2014, excluding 3 LDCs (Solomon Islands, South Sudan, Tuvalu) and 7 non-LDCs (DPR Korea, Marshall Islands, Federated States of Micronesia, Nauru, Palau, Singapore, Turkmenistan).

4.2 Changes over time in the distribution of the HAI and its components

The variance in the HAI scores and in the four components for the DC group has decreased between 1990 and 2014. However, this is not the case for the variance in the HAI scores for the LDC group, probably because of a larger variance in the Secondary enrolment rate that is not compensated by the other components.

Table 8. Changes in standard deviations, HAI and components

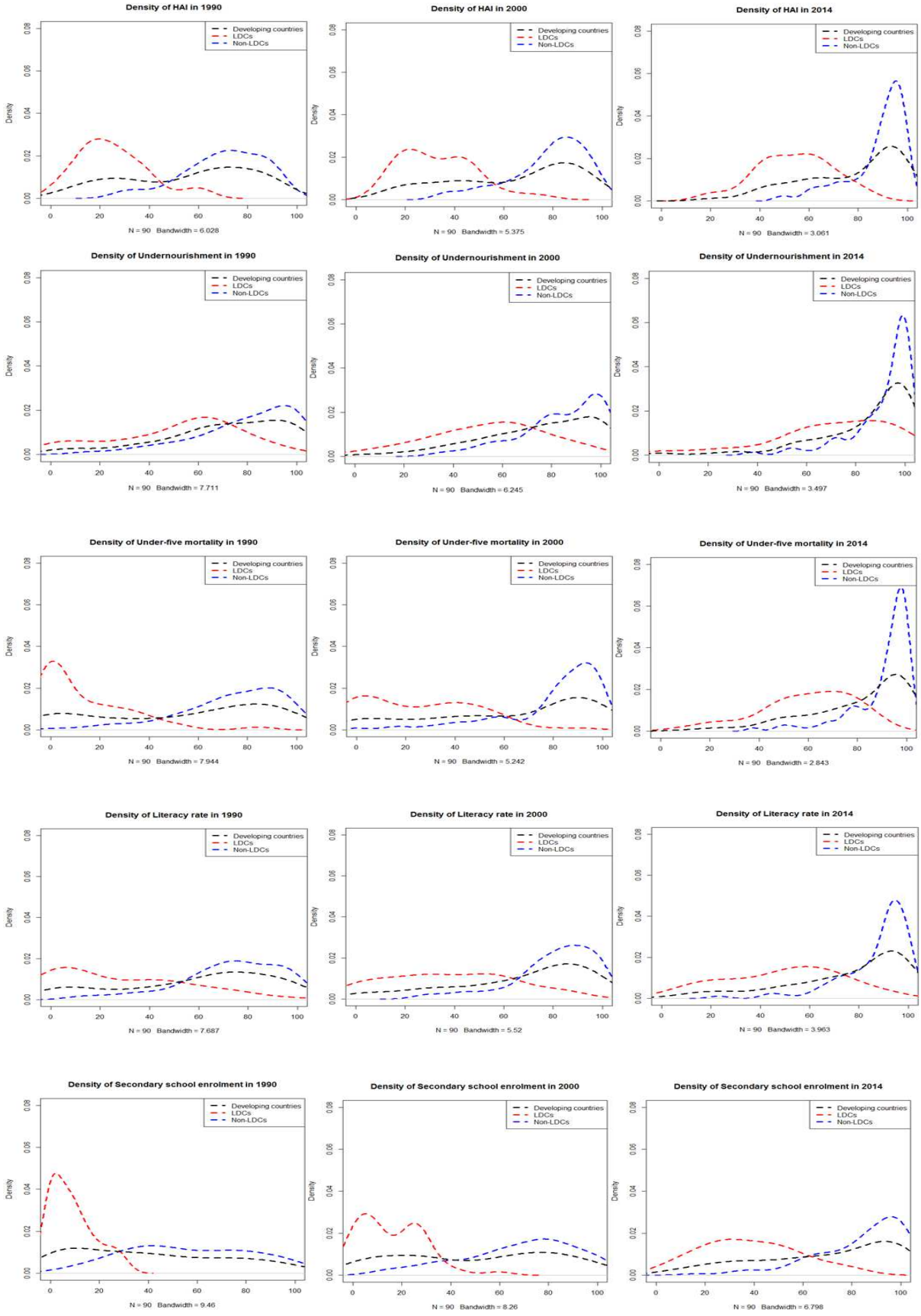
	19902014		change
Developing countries			
HAI	26,4	20,7	−5,7
Undernourishment	26,4	20,6	−5,7
Under5mortality	34,8	21,1	−13,8
Literacy	31,1	25,3	−5,8
SecondaryEnroll	31,2	28,5	−2,7
Least developed countries			
HAI	14,6	15,6	+1,0
Undernourishment	26,2	25,7	−0,4
Under5mortality	18,8	19,6	+0,7
Literacy	27,1	23,8	−3,2
SecondaryEnroll	9,0	20,4	**+11,4**

The following graphs report the distribution density for the HAI and its 4 components, for the years 1990, 2000 and 2014, for 45 LDCs and 90 non-LDCs. The shapes of distributions and their deformation over time are different across components. As expected, because of fixed maximum values over time, distributions tend to shift to the right and agglomerate nearby 100. This is particularly the case for undernourishment, under-five mortality and literacy indices, and for the group of non-LDCs. LDCs' backwardness is visible, but more on education than on health. Distributions are more flat, signaling heterogeneity, for LDCs and the literacy index particularly.

4.3 Education versus health progresses and their correlation

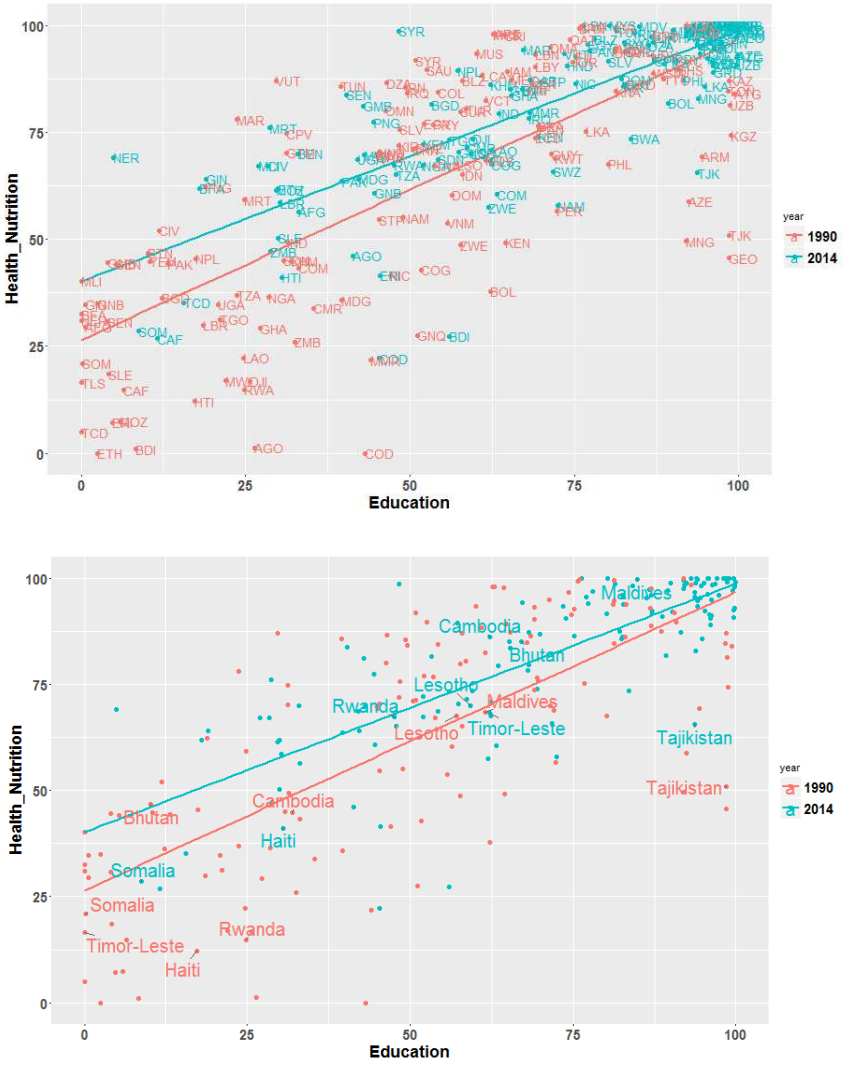
The following figure plots Education (computed as the simple average of Adult literacy rate index and Gross secondary school enrolment ratio index, x-axis) against Health (computed as the average of under-five mortality index and percentage of population undernourished index, y-axis) for the 135 countries in 1990 (red) and 2014 (blue). A somewhat expected positive association appears between education and health in both years, in terms of levels and trends. The magnitude of relationship seemed to vary over time: the correlation is higher in 2014 than in 1990 (spearman rank's correlation of 79.5% versus 73.2%). From 1990 to 2014, the sample of countries tends to shift to the above-right, but improvements are not uniform across countries. Some countries do not follow the general trend as highlighted in Figure 7.b. For instance, Bhutan, Rwanda, Cambodia and Timor-Leste have made enormous strides in terms of education but even more on health. Tajikistan, despite a high score in education has not made progress in health.

Figure 8. Distribution density of HAI and its components over time



Notes: Constant sample of 135 DCs o.w. 45 LDCs.

Figure 9. Education (x) and Health (y) in 1990 (red) and 2014 (blue)



Notes: Constant sample of 135 DCs o.w. 45 LDCs over 1990-2014, excluding 3 LDCs (Solomon Islands, South Sudan, Tuvalu) and 7 non-LDCs (DPR Korea, Marshall Islands, Federated States of Micronesia, Nauru, Palau, Singapore, Turkmenistan).

5. Conclusions

This working paper details the methods used to build retrospective series of the Human Assets Index, and its four components, which cover 145 countries for the period 1990-2014. Based on group averages, we observe a continuous increase in the HAI in the last decade. Despite a larger increase for LDCs, there is still a big gap between LDC and non-LDC averages. Furthermore, the variance in the HAI scores for the LDC group has maintained over time because of a larger variance in the Secondary enrolment rate that is not compensated by a lower variance in the other components. Future work should aim at gathering new data on the HAI components and improving methods for imputation of missing data, as well as strictly following the changes in the UN-CDP methodology.

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Appendix

Figure 10. HAI in LDCs in 2014

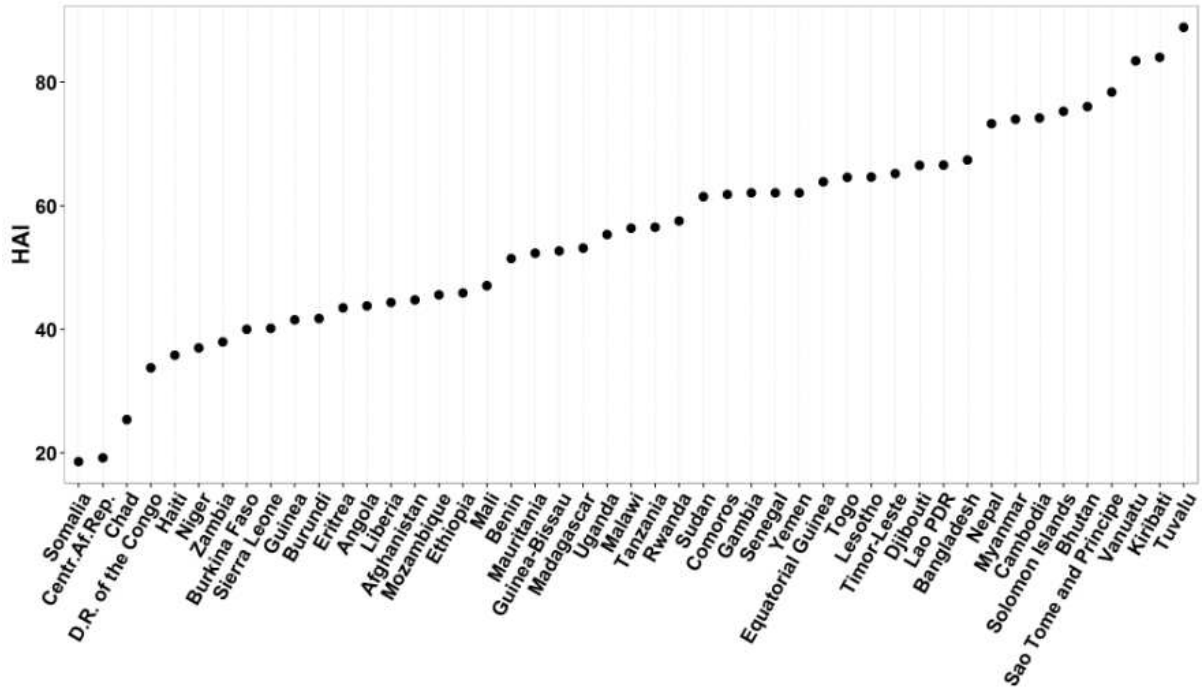

Figure 11. HAI on the MAP in 2014

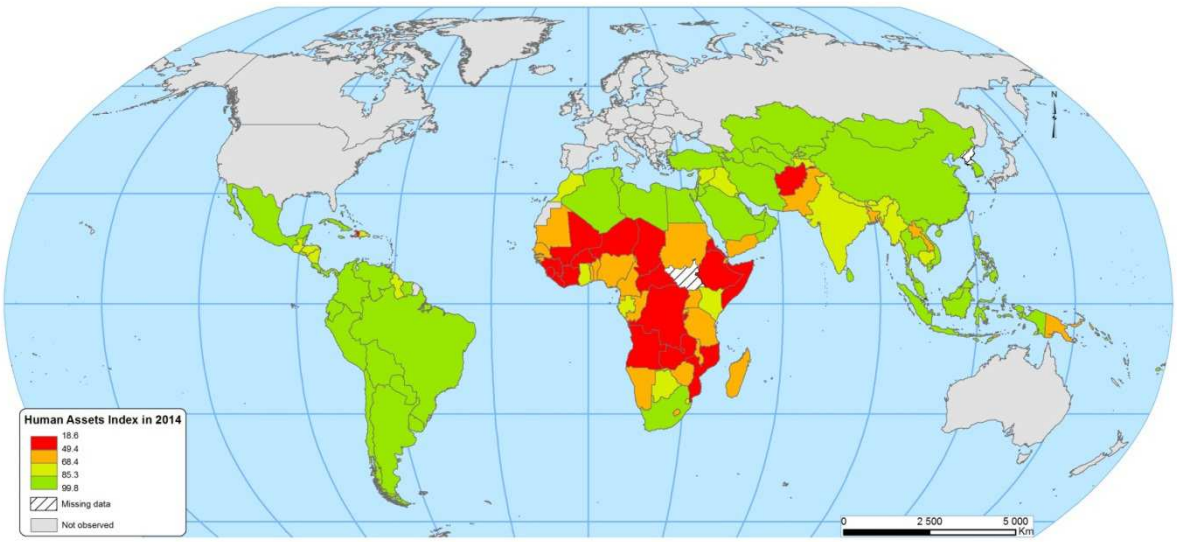

Table 9. HAI in LDCs (year 2014)

Country	ISO	U_index	LR_index	U5MR_index	SE_index	HAI
Afghanistan	AFG	63.7	15.4	49.2	50.7	44.7
Angola	AGO	84.7	61.3	7.8	21.4	43.8
Burundi	BDI	0.0	81.1	54.8	31.0	41.7
Benin	BEN	95.8	16.5	44.2	49.3	51.4
Burkina Faso	BFA	73.8	13.5	50.1	22.6	40.0
Bangladesh	BGD	81.0	47.5	82.1	59.0	67.4
Bhutan	BTN	84.8	51.6	85.2	82.4	76.0
Central African Republic	CAF	28.8	15.7	24.8	7.4	19.2
Dem. Rep. of the Congo	COD	0.0	53.3	44.4	37.2	33.7
Comoros	COM	61.0	69.5	60.1	56.8	61.8
Djibouti	DJI	81.8	78.7	65.2	40.4	66.5
Eritrea	ERI	6.2	63.6	76.9	27.2	43.5
Ethiopia	ETH	55.0	30.4	68.6	29.6	45.9
Guinea	GIN	81.0	5.9	47.3	32.0	41.5
Gambia	GMB	99.5	39.2	63.0	46.6	62.1
Guinea-Bissau	GNB	73.8	45.1	47.8	43.9	52.7
Equatorial Guinea	GNQ	93.6	93.4	47.0	21.5	63.9
Haiti	HTI	19.3	45.9	63.0	15.1	35.8
Cambodia	KHM	84.7	68.9	87.5	55.7	74.2
Kiribati	KIR	100.0	85.6	71.3	79.2	84.0
Lao PDR	LAO	77.5	72.2	64.2	52.5	66.6
Liberia	LBR	55.2	29.4	61.9	31.0	44.3
Lesotho	LSO	89.7	71.7	50.3	46.9	64.6
Madagascar	MDG	53.3	52.8	74.8	31.6	53.2
Mali	MLI	100.0	16.6	34.4	37.2	47.0
Myanmar	MMR	84.7	90.6	74.7	45.9	74.0
Mozambique	MOZ	66.2	43.2	56.8	16.1	45.6
Mauritania	MRT	99.0	35.0	53.0	22.2	52.3
Malawi	MWI	73.8	53.2	65.5	32.8	56.3
Niger	NER	92.5	0.0	45.7	9.8	37.0
Nepal	NPL	95.3	51.2	83.4	63.2	73.3
Rwanda	RWA	55.7	59.7	79.2	35.5	57.5
Sudan	SDN	75.0	66.8	62.3	41.8	61.5
Senegal	SEN	91.7	32.3	75.9	48.3	62.1
Solomon Islands	SLB	89.5	79.0	88.5	43.9	75.2
Sierra Leone	SLE	71.2	29.2	29.5	30.8	40.1
Somalia	SOM	36.6	17.3	20.5	0.0	18.6
South Sudan	SSD	68.2	8.3	48.1	-	-
Sao Tome and Principe	STP	97.3	65.5	76.4	74.3	78.4
Chad	TCD	51.0	18.9	19.5	12.2	25.4
Togo	TGO	89.3	53.4	57.1	58.6	64.6
Timor-Leste	TLS	63.5	54.2	73.0	70.1	65.2
Tuvalu	TUV	94.2	93.4	89.1	78.6	88.8
Tanzania	TZA	54.8	73.2	75.5	22.5	56.5
Uganda	UGA	65.8	63.5	71.6	20.4	55.3
Vanuatu	VUT	97.7	79.5	89.0	67.5	83.4
Yemen	YEM	64.8	58.5	79.5	45.6	62.1
Zambia	ZMB	28.7	50.8	65.7	6.6	38.0

"Sur quoi la fondera-t-il l'économie du monde qu'il veut gouverner? Sera-ce sur le caprice de chaque particulier? Quelle confusion! Sera-ce sur la justice? Il l'ignore."

Pascal

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