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Towards a more 'Sustainable' Human Development Index: Integrating the environment and freedom

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ABSTRACT

The Human Development Index (HDI) is one of the most widely used composite indicators of socio-economic development. However, the HDI is at the cross-roads. In order to retain its flagship role in the development arena, many scholars have called from the HDI to reinvent itself by adding sustainability dimensions.

The aim of this paper is to introduce the Sustainable Human Development Index (SHDI), based on Multidimensional Synthesis of Indicators (MSI) – a new class of indexes that can be used for monitoring Sustainable Human Development (SHD). The approach we propose aims to address two primary issues regarding the HDI.

The first issue involves the integration into the SHDI of two important sustainability-related dimensions that are missing in the HDI; namely, the environment and freedom (defined here in terms of political rights and civil liberties). The second issue focuses on the method of aggregation using the new class of indexes proposed. We aim to expand on the three standard HDI dimensions while avoiding problems associated with the geometric mean that tends to collapse to zero. In doing so, we manage to retain the same theoretical intuitions of the post-2010 HDI approach, i.e. to penalize the heterogeneity of outcomes.

Moreover, we rely on the flexibility of the MSI approach to develop another index, the Environmentally-centered Sustainable Human Development Index (ESHDI), which puts the environmental dimension at the core of the analysis.

In the first part of the paper we introduce the theoretical debate on the multidimensionality of the HDI, and consider the two new dimensions of sustainability, as well as the MSI aggregation approach. In the second part, the SHDI and the ESHDI are introduced, tested through a simulation analysis, and are compared with the HDI geometric mean using 2013 data.

The simulations and the results of the empirical analysis show how the new class of indexes provide a more flexible approach to the procedure of aggregation, especially when the number of dimensions increases and/or when there is the need to stress the importance of one or more dimensions. The introduction of the two environmental and freedom sustainability dimensions greatly increases the potential of the HDI to address the SHD paradigm by capturing two core issues for the humanity and its common future.

1. Introduction

The Human Development Index (HDI), introduced by UNDP (United Nations Development Programme) in 1990, is considered a central indicator of the Human Development (HD) paradigm, and is widely recognized to hold a relevant role in the development arena vis-à-vis GDP and GDP per capita (Klugman et al., 2011; Dervis and Klugman, 2011; Morse, 2014). However, even though this composite index features a "conglomerative perspective", and is intended as a comprehensive approach for analyzing the conditions of everyone in society (Anand and Sen, 1997, p. 1), several concerns, both substantial and technical, have emerged in the literature (Desai, 1991; Morse, 2003; Kovacevic, 2010; Togtokh and Gaffney, 2010; Ranis and Stewart, 2010; Herrero et al., 2010; Dervis and Klugman, 2011; Neumayer, 2011; Herrero et al., 2012; Morse 2014). Although the HDI has evolved over time, with changes in calculation technicalities and the dimensions' indicators (Morse, 2014), at least two main issues continue to attract the attention of researchers.

The first issue involves a technical concern of the new HDI (i.e. post-2010 version): the geometric mean exhibits some well-known problems

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of calculations when the number of dimensions increases and when one or more components are close to zero, when "the value of the whole index collapses to zero" (Klugman et al., 2011, p. 24). The geometric mean aggregation method should therefore be improved – especially if extra dimensions are added.

The second issue, involves the HDI's 'original sin' of neglecting environmental and social sustainability issues. The environmental/ecological dimension (Dahme et al. 1998; Sagar and Najam, 1998; De la Vega et al. 2001; Togtokh, 2011; Pelenc et al., 2013) and the social/freedom dimension associated here with political rights and civil liberties (Dasgupta, 1990; Desai, 1991; Ranis and Stewart, 2010) are considered as 'missing dimensions' in the standard HDI (UNDP, 1996; Neumayer, 2001; Ranis et al. 2006; Biggeri and Mauro, 2010; Hirai, 2017).

Moreover, the integration of both an environmental dimension[1] and a freedom dimension in HDI are a top priority the 2030 Agenda on Sustainable Development and within the Sustainable Development Goals (SDGs),[2] If HD is about empowering people to lead long, healthy, educated and fulfilling lives (UNDP, 1990; Sen, 1999), then HD without being sustainable and empowering is difficult to accept.

Several researches have tried to integrate the environmental dimension in the HDI (Dahme et al., 1998; Ramathan, 1999; De la Vega et al., 2001; Neumayer, 2001; Morse, 2003). In particular, the Human Sustainable Development Index (HSDI) introduced by Togtokh and Gaffney (2010) and improved by Bravo (2014), and the adjusted HDI (to include a loss function) introduced by Pineda (2012), represent the most concrete attempts to overcome the 'original sin'. Few studies try to include the freedom dimension (Dasgupta, 1990; Desai, 1991; Hirai, 2017), and less attempts have been made to integrate both of these two dimensions into the HDI (Hirai, 2017).

The aim of this paper is to introduce the Sustainable Human Development Index (SHDI) based on a new class of measures that aim to address two primary concerns.

The first is the introduction of dimensions that are missing in the HDI. Adding environmental and freedom indicators to the index allows us to assess the performances of countries in other important areas such as environmental protection and human rights (Togtokh, 2011; Bravo, 2014, 2015) and matters pertaining to civil and political rights (Ranis and Stewart, 2010).

The second point focuses on the method of aggregation for the dimensions selected. The new formula of the HDI introduced in 2010 aims to take account of the heterogeneity of outcomes using a geometric mean, which is less appropriate when many indicators are considered (UNDP, 2010). To address this crucial issue, our index is based on the Multidimensional Synthesis of Indicators (MSI, Mauro et al., 2016), a class of indexes that allows more flexibility in the management of substitutability between dimensions. Although this class of indexes does not completely eliminate the subjective nature of some choices, it has the merit of making them explicit, and also obliges those making these choices to justify them. This approach permits to expand the three standard HDI dimensions avoiding the problems of the geometric mean aggregation method, while maintaining the same relevant theoretical intuition.

Moreover, the MSI method of aggregation allows us to perform analyses that focus on specific dimensions. For example the attention can be devoted to the environmental considerations by penalizing countries that perform poorly in this specific dimension. We rely on the flexibility of this approach to develop another index, the Environmentally-centered Sustainable Human Development Index (ESHDI), which puts the environmental dimension at the core of the analysis.

The remainder of the paper is structured as follows: the second section introduces the theoretical debates on multidimensionality and sustainability. The third section focuses on the aggregation method proposed and the data used. The fourth section presents the SHDI and the ESHDI are examines their properties through simulation analyses. The fifth section, discusses and compares the performance of the two new indexes with the old geometric mean using 2013 data for a sample of 50 countries (from UNDP, World Bank and Freedom House Data). In the final section, the main findings and conclusions are reported.

2. The HD paradigm, the HDI and the new dimensions

Although the HDI detains an important role in political terms in the development arena, it represents just one among the main elements of the UNDP's HD paradigm, which is built on the Basic Needs framework and the Capability Approach (UNDP, 1990).

According to the HD perspective, "the main objective of development is to create an enabling environment for people to enjoy long, healthy and creative lives" (Haq and ul, 1995, p. 29). Indeed, "the view of human beings as the 'primary ends' of the process of development calls for emphasis to be placed on what people get from development, not only what they put into it." (Anand and Sen, 2000a,b). In brief, the HD paradigm is based on four main pillars: equity, productivity, empowerment, and sustainability (UNDP, 1996; Comim et al., 2008; Deneulin, 2009). The Sustainable Human Development (SHD) can be defined as a process of promotion and expansion of valuable human capabilities (opportunities) where the term 'sustainable' refers to environmental and social sustainability (Biggeri and Ferrannini, 2014). Therefore, according to the SHD, any development process should aim to reduce poverty, inequality and conflicts but also to promote inclusion, participation and environmental stress and ecological conditions. In other words, although extremely relevant, "[The HDI] is a quick and imperfect glance at human lives, which—despite the crudeness it shares with the GNP—is sensitive, to a significant extent, to the way people live and can choose to live. However, the breadth of the human development approach must not be confused with the slender specificity of the Human Development Index" (Sen, 2006, p. 257).

Therefore, the main argument found in the literature is that HDI is too limited to encompass the concept of HD with its three existing dimensions (Sen, 2006; Hirai, 2017). According to several researchers, the HDI does not, in fact, include all dimensions that might – or should – be of interest (Fukuda-Parr, 2000).[3] Hirai (2017, p. 75) argues that "'freedom' and [the] 'environment' seem the most debated as … additional desirable dimension[s]" for HDI integration. In this perspective, it is also important to emphasize that the UNDP's attention to sustainability is nowadays remarkably strong.[4] The initial UNDP's HDR of 1990 (that launched the HDI) clearly stated that "The most critical ones are to lead a long and healthy life, to be educated and to enjoy a decent standard of living. Additional choices include political freedom, guaranteed human rights and self-respect …" (UNDP, HDR, 1990, p. 13). According to the same report, "while the conceptual and

[1] This includes, for instance, the report on Sustainable Development in the European Union (EU, 2010), International Energy Outlook (2017) and the goals proposed in the Sendai Framework for Disaster Risk Reduction (2016).

[2] 17 SDGs are considered when calculating a country's HDI. During this process, a set of indicators and targets have been identified and created. At least 10 out of the 17 goals feature a precise reference to sustainability and environmental goals (items 2, 6, 7, 8, 9, 11, 12, 13, 14, and 15), while some of the goals are directly or indirectly linked to political rights and civil liberties.

[3] For a literature review of different human indicators review Smith et al (2013) and Morse (2014) see also Clark and Hulme (2010). For instance, among the attempts, Gustav Ranis, Frances Stewart and Emma Samman (2006), in their article "Human Development: Beyond the Human Development Index", extended the measurement of HD to 11 important categories of life.

[4] This last point strongly implies that the quality of growth matters. According to the UNDP (1996), there are several different kinds of growth: 'jobless growth' (which does not expand the opportunities for employment), 'ruthless growth' (in which the fruits of growth mostly benefit the rich), 'futureless growth' (where present generations squander valuable resources), and 'peace-less growth' (which feeds conflicts) (Biggeri and Mauro, 2010).

methodological problems of quantifying and measuring HD are even more complex for political freedom, personal security, interpersonal relations and the physical environment, analyses of human development must not ignore them" (UNDP, HDR, 1990, p. 13). Moreover, according to HDR (1996), an enhanced HDI would consider environmental sustainability and issues pertaining to freedom (UNDP, 1996). If the efforts that try to integrate both dimensions are almost absent (Biggeri and Mauro, 2010; Hirai, 2017) while the works to incorporate separately each single dimension are several.

Attention to environmental sustainability has increased[5] since the Brundthland Report on *Our Common Future* (1987) and is at the core of UNDP's approach nowadays (UNDP Strategic Plan 2018-2021). Indeed, "One of the biggest challenges of this century will be severing the link between high to very high levels of human development and strong [levels of environmental] unsustainability, particularly in the form of unsustainably high carbon dioxide emissions." (Neumayer, 2012, p. 576). Therefore, it is essential to reconcile HD and the environmental/ecological dimension of sustainability (Constantini and Monni, 2005; Neumayer, 2012; Pelenc et al., 2013).[6]

In terms of concrete measurement, environmental concerns about the HDI became a hot topic in the late 1990s (Hirai, 2017). The first attempt to incorporate environmental issues in the HDI goes back to Desai (1995), which was followed by various other attempts (Hirai, 2017). Recent work by Togtokh and Gaffney (2010), Togtokh (2011) and by Bravo's (2014, 2015) included the environmental dimension in the HDI by using CO_2 emissions.

Meanwhile, the lack of a freedom dimension was already acknowledged in the 1990 HDR. As a matter of fact, the 1993 HDR (*People's Participation*) the 2002 HDR (*Deepening Democracy in a Fragmented World*), and the 2010 HDR (*The Real Wealth of Nations: Pathways to Human Development*) made a strong case for adding freedoms and rights issues to the HD paradigm, thereby emphasizing the need to consider this domain.

According to Hirai (2017), the works to integrate HDI dimensions with freedom began in 1990 with Dasgupta (1990) who first stressed its absence from the perspective of human rights. This was attempt was followed by others such as Desai (1991), Hopkins (1991), Kelley (1991) and Trabold-Nübler (1991). Dasgupta (1990) and Dasgupta and Weale (1992) added the political and civil liberties to the HDI and further contributions on this topic followed (Hirai, 2017).

3. A new method of aggregation and the data

3.1. A new method of aggregation

The post-2010 HDI replaced the arithmetic mean of the three components of this index with the geometric mean (UNDP, 2013). This change introduced relevant properties such as the "penalisation" of countries' heterogeneous achievements, and brought it in line with the theoretical requirements of the HD paradigm and the capability approach (Sen, 2006; Desai, 1991; Dervis and Klugman, 2011; Zambrano, 2014). Despite these substantial theoretical and empirical improvements, the new approach can still create problems, especially as the number of dimensions increases. Similar problems can emerge if some of the components are close to zero and if the geometric mean falls prey to some well-known problems involving calculations (Klugman et al., 2011) and interpretability.

To address these problems, a new class of indexes that aggregates different dimensions of SHD into a unidimensional value is introduced. This new approach allows us to expand the three standard HDI dimensions and penalize heterogeneity between achievements without facing the problems associated with the geometric mean method of aggregation.

An index that aggregates several different indicators is a function that satisfies some desirable properties to properly monitor SHD. Throughout the remainder of this paper, we will use "index," "synthesis," and "function" interchangeably, referring to a $R^k \rightarrow R$ function mapping a *k*-dimensional real-valued vector (the achievements of a single country) into a single real value (the final aggregate score). Without loss of generality, we assume that all the achievements are measured using normalized values between 0 and 1 (using the HDI approach). Although the aim of this paper is not concerned with the properties of the index (see Mauro et al., 2016), we briefly introduce some key properties that are important for the remainder of the discussion.

The first property requires that any change in HD dimension in given country must be captured by the index. This condition, which we refer to as "strict monotonicity," guarantees that any improvement (or decline) of a country in a dimension must result in an increase (or decrease) of its synthetic score. Second, the function must be continuous. Small changes in the data must cause small changes of the index. Third, an appropriate synthesis should take account of the heterogeneity between accomplishments. Indeed, the overall score of countries that feature significant differences between their achievements should be penalized. This property is closely linked to the degree of substitutability among indicators: when the substitutability is not perfect, a low score in one dimension is not compensated in a linear manner by a high score in another dimension. The decision of UNDP to use a geometric mean is an attempt to address this issue, as the HDI introduced in 2010 accounts for imbalances between indicators by discounting each dimension's mean value according to its level of inequality (Dervis and Klugman, 2011).[7]

The last property we focus on, involves the elasticity of the substitution rate between sub-indexes, and is entailed in many synthetic indicators based on higher-order means (Biggeri and Mauro, 2010; Klugman et al., 2011; UNDP, 2013). We already pointed out how the geometric mean used in the HDI reduces the level of substitutability between dimensions. Nonetheless, as soon as the number of dimensions increases, it could lose its functionality, as poor performances in one or more dimensions might result in over-penalization. For example, if at least one score is zero, then the geometric mean is automatically given a score of zero as well. Since the goal of this work is to extend the number of dimensions being considered, we need a function that encourages flexible substitutability without bringing about the crucial limitation that stems from using a geometric mean.

A common issue with synthetic indicators is that the elasticity of substitution between basic indicators is strictly dependent on the choice of a parameter (usually the order of the mean). The main issue with this approach is that, once this parameter is set, it allows no elasticity to the substitutability rate between achievements. Mauro et al (2016, 2017) try to address these concerns by showing how a certain degree of

[5] Two good examples of the UNDP's Human Development Report Office (HDRO) are: the 2007/08 HDR on Fighting climate change: Human solidarity in a divided world considers the environment and sustainability dimensions (UNDP, 2007); and the 2011 HDR on Sustainability and Equity: A Better Future for All puts sustainable HD at the center of the debate (UNDP, 2011).

[6] According to Pelenc et al. (2013), one of the major shortcomings of Sen's capability approach is its weak ecological dimension (Max-Neef, 1991), although Anand and Sen stated that "there is, in principle, no basic difficulty in broadening the concept of human development to accommodate the claims of the future generations and the urgency of environmental protection." (Anand and Sen, 2000b, p. 2030). Pelenc and his colleagues have overcome this issue by devising an approach that takes into consideration the intrinsic and instrumental values of nature. They include an ecological dimension that considers sustainability issues, while also putting forward a concept of agency that envisions a wide variety of actors who are capable of generating SHD. See also Wouter et al. 2013, 2015

[7] The UNDP also introduced the Inequality Adjusted Human Development Index (IHDI), an alternative measure that accounts for inequalities in HDI dimensions by "discounting" each dimension's average value according to its level of inequality. This approach, nonetheless, considers only the within-dimension source of inequality, and it does not include the heterogeneity between dimensions that we analyze in this paper.

flexibility can be retained by using a function of the general well-being for each country. This means that a lower degree of substitutability assigns a higher relative weight to the lowest score, especially among poor countries.

Let X be the standard $n_x k$ data matrix with generic entry x_{ij} the j-th achievement for country i. Then

$$\mathrm{MSI}_i = 1-\left[\frac{1}{k}\sum_{j=1}^{k}(1-x_{ij})^{g(\cdot i)}\right]^{\frac{1}{g(\cdot i)}} \quad (1)$$

where k is the total number of dimensions (five for the SHDI) and $g(\cdot_i)$ is a generic real-valued function of the i-th row of matrix, with $g(\cdot) \geqslant 1$. $g(\cdot) > 1$. The function $g(\cdot)$ allows a high degree of flexibility in the index, and it can take account of theoretical considerations regarding the structure of substitutability rates between achievements. If the function $g(\cdot) = \alpha$ is constant, with $\alpha > 2$, then the synthesis is a higher-degree average with a lower degree of substitutability (a case of $\alpha > 2$ is analysed in Anand and Sen, 1997). As α increases, the iso-capabilities curves mapping the levels of outcomes consistent with a given level of well-being will converge to a Leontief functional form where there is no substitutability between achievements (Klugman et al., 2011). Anand and Sen (1997) stress that there is no flexibility in the rate of substitutability between indicators once the α parameter is set. They refer to this problem as "inescapable arbitrariness in the choice of the parameter α" (Anand and Sen, 1997, p. 16).

The approach we propose in formula (1) is thus valuable because the degree of substitutability can be directly linked to the general level of well-being of each country[8] through a non-constant function $g(\cdot)$. Given the instrumental value of most dimensions, this means that a sharp deprivation in a specific dimension might cause not only an overall deprivation (intrinsic value), but also negatively affect other dimensions (instrumental value). Further information (or assumptions) on the structure of the substitutability rates can lead to more detailed and complex reiterations of the functional form[9] of the function $g(\cdot)$ that are beyond the purpose of this work. Put simply, this synthesis penalizes heterogeneity while avoiding the issues associated with using the geometric mean. This consideration mirrors Sen's notion of 'development as freedom' (Sen, 1999). Nonetheless, it is important to point out that the flexibility of the function $g(\cdot)$ is inevitably linked to a subjective choice. In this approach, we do not claim to have completely addressed the "inescapable arbitrariness" issue mentioned by Anand and Sen, but rather to have made it flexible and explicit, allowing for a more transparent exploration of the theoretical and empirical link between human freedom and human development.

3.2. The data

For primary reasons debated in Section 2, we decided to include in this paper the three standard dimensions of the HDI with the two dimensions most commonly cited as crucial omissions: the environment and (negative) freedom.

The environmental dimension is measured by per capita carbon dioxide (CO_2) emissions. The same proxy has been used by several researchers (Ranis et al, 2006; Biggeri and Mauro, 2010) and in the Human Sustainable Development Index (HSDI) by Togtokh and Gaffney (2010) and Bravo (2014, 2015). Data on per capita carbon dioxide were obtained from the World Bank's *World Development Indicators* (WDI). Carbon omissions come about by burning fossil fuels and manufacturing cement. They include carbon dioxide produced during gas flaring and the consumption of solid, liquid, and gaseous fuels. The standardization of this variable is consistent with the approach used by the HDI and was made by using the highest observed value in the 2005–2013 period, and by setting the minimum to zero (representing a fully decarbonized economy, Bravo, 2014).

The freedom dimension is based on political and civil rights. The data to measure this dimension were taken from Freedom House's *Political Rights and Civil Liberties Rights Index*. Both indexes are based on a scale ranging from 0 to 7. These indexes are obtained from a survey measuring freedom (the opportunity to act spontaneously in a variety of fields outside the control of the government and other centers of potential domination) according to two broad categories: political rights and civil liberties. The data are based on numerical ratings for each country or territory. Political rights enable people to participate freely in the political process, including the right to vote for distinct alternatives in legitimate elections, compete for public office, join political parties and organizations, and elect representatives who have a decisive impact on public policies and are accountable to the electorate. Civil liberties allow for the freedom of expression and belief, associational and organizational rights, the rule of law, and personal autonomy without interference from the state. The final index for this dimension is calculated as the average of political rights and civil liberties in a given country (the overall index scored between 1 and 6.5) In the standardization 0–1 we used the methodology of HDI (with min and max set to 0.5 to 7).

Although these variables are popular and widely-used (for example, political and civil rights are considered as the most important indicators of political freedom by many human development scholars, e.g. Drèze and Sen, 2002; Hirai, 2017), the available indicators employed in this paper are still not sufficient for fully capturing the complex and diverse nature of the environmental dimension[10] and political freedom.[11]

4. The SHDI and the ESHDI and data simulations

4.1. The SHDI

The SHDI proposed in this paper is a particular example of a MSI in which countries are treated as units, five dimensions are analyzed (the traditional three used in the HDI and the two new dimensions), and the function chosen to manage substitutability rates is $g(\cdot) = \mu^{-1}$, where μ is the arithmetic mean[12] of the row x_i. This choice of function g is the basic standard proposed by Mauro et al (2016, 2017), which can be considered an appropriate choice for the SHDI given its simplicity and straightforward nature. Despite this, different scenarios and contexts might require the use of different forms of this parameter (as discussed in the next sub-section), although it is worth emphasizing that the precise choice remains transparent and explicit.

$$\mathrm{SHDI}_i = 1-\left[\frac{1}{k}\sum_{j=1}^{k}(1-x_{ij})^{g(x_i)}\right]^{\frac{1}{g(x_i)}} \quad (2)$$

[8] For instance, Bourguignon and Chakravarty (2003) and Chakravarty (2003) propose individual poverty measures with this property.

[9] The choice of μ for measuring the level of individual well-being and its value in characterising the heterogeneity structure is not purely arbitrary. A sensitivity analysis using different measures (e.g. an iterative method leading to a sufficient degree of convergence after 3–4 iterations) showed no significant differences in the final measurements. Thus, a simple function using an arithmetic mean seems to be the best choice in the absence of additional information on the structure of substitutability rates.

[10] The most widely used indicator is the one we applied. The number of environmental indicators are increasing in the literature. The most well-known is the Environmental Performance Index (EPI), which ranks 180 countries on 24 performance indicators across ten categories covering environmental health and ecosystem vitality. See https://epi.envirocenter.yale.edu/10

[11] Consider *The Human Freedom Index – 2017*, for instance, which presents a broad measure of human freedom, intended to capture the absence of coercive constraints (Vásquez and Porčnik, 2017). This index uses 79 distinct indicators of personal and economic freedom that cover the following areas: Rule of Law; Security and Safety; Movement; Religion; Association; Assembly; and Civil Society; Expression and Information; Identity and Relationships; Size of Government; Legal System and Property Rights; Access to Sound Money; Freedom to Trade Internationally; and Regulation of Credit; Labor; and Business (Vásquez and Porčnik, 2017).

[12] The MSI requires $g(.) \geqslant 1$. This is always true if variables are bounded between 0 and 1 as assumed.

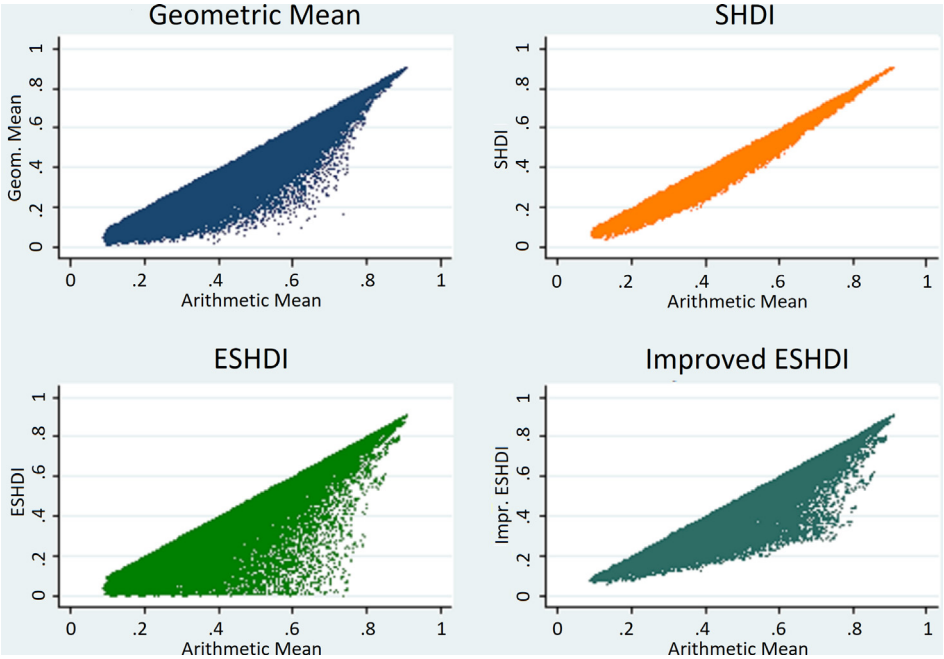

Fig. 1. Comparison between Geometric mean (HDI), the SHDI, and the ESHDI throughout the arithmetic mean. *Source*: Authors.

Table 1
HDI components and new dimensions; proxy variable normalized for selected countries (2013).

Variable	Obs	Mean	Std, Dev,	Min	Max
GNP	50	0.768	0.120	0.499	0.976
EDU	50	0.706	0.131	0.447	0.927
LE	50	0.847	0.091	0.568	0.978
CO_2	50	0.812	0.154	0.376	0.992
FRE	50	0.688	0.248	0.077	0.923

Source: Authors based on data from World Bank WDI (2017, various years), Freedom House (2017, various years), and HDI Trends UNDP (2017, various years).

This is a simple and intuitive way of allowing for a flexible penalization of heterogeneity in achievements; countries with better outcomes are penalized less, while poorer countries are penalized more, as heterogeneity is interpreted as a lack of effective opportunities (Ranis and Stewart, 2010). In other words, the degree of substitutability is a function of the overall achievement of the country, which is estimated through the arithmetic mean of the indicators.[13]

The flexibility of the SHDI is in line with Sen (1985, 1999), where opportunities or capabilities are intended as freedoms of a country and can be easily linked to their flourishing (Brandolini and D'Alessio, 1998; Ranis and Stewart, 2010; Klugman et al., 2011). Therefore, outcomes reached in different dimensions act as proxies for the opportunities that are available to the citizens of a certain country. When the level of general development is low, the need for synergy between dimensions is higher.

4.2. The ESHDI

There is no upper limit to the flexibility of $g(\cdot)$, as long as it satisfies some basic properties. To devote even more attention to the environmental/ecologic dimension, with special emphasis on how it influences the other dimensions, we also propose an alternative version of the index, replacing the overall mean in the substitutability parameter with the score found in the environmental dimension.

Let e_i be the reciprocal of the achievement measured in the environmental indicator for country i, then the overall score for the i-th country, is

$$\text{ESHDI}_i = 1-\left[\frac{1}{k}\sum_{j=1}^{k}(1-x_{ij})^{e_i}\right]^{\frac{1}{e_i}} \tag{3}$$

To distinguish this version of the index, we have added the prefix 'E' (environmentally-centered) to SHDI.

In the next sub-section, we present some simulations using the two indexes introduce with formulas (2) and (3) we have proposed and compare them to the HDI. In Section 6, these comparisons are applied to country-level real data to determine how the different indexes perform at country level.

4.3. The data simulations

The dataset created to check the performances of these indexes contains $n = 200{,}000$ simulated observations and $k = 5$ variables (to simulate the three standard dimensions in the HDI, plus the two environmental and social sustainability variables). Without loss of generality, all variables are assumed to be normalized, and therefore bounded between 0 and 1. The dataset is created with the assumption that the vector containing the n arithmetic means of the observations is uniformly distributed[14].

The aim of the three indexes we analyze is to measure the level of HD when inequality is accounted for. The three indexes under analysis satisfy the same key property: they equal the arithmetic mean when there is no inequality across dimensions, but fall below it as inequality rises. For this reason, we present the performances of the indexes using a distance from the arithmetic mean: the higher the distance, the more penalized the country. The upper part of Fig. 1 shows the behavior of

[13] The function is not defined for $\mu = 0$. Therefore, we exclude countries where all variables are 0.

[14] Without this assumption, the distribution of the n arithmetic mean would be normally distributed according to the Central Limit Theorem. This would cause an over-representation of units with "average" scores that could bias the interpretation the results.

Table 2
Arithmetic mean, Geometric Mean, SHDI and ESHDI (year 2013).

Country	R_HDI	DevSt	Amean	Gmean	SHDI	ESHDI	Dist. Gmean	Dist. SHDI	Dis. ESHDI
Norway	1	0.150	0.873	0.861	0.864	0.835	−1.4%	−1.0%	−4.3%
Australia	2	0.213	0.835	0.806	0.818	0.732	−3.5%	−2.1%	−12.3%
Netherlands	3	0.115	0.867	0.860	0.862	0.849	−0.8%	−0.6%	−2.0%
United States	4	0.208	0.824	0.796	0.807	0.729	−3.4%	−2.0%	−11.6%
New Zealand	5	0.079	0.880	0.877	0.877	0.873	−0.3%	−0.3%	−0.7%
Denmark	6	0.062	0.880	0.878	0.878	0.877	−0.2%	−0.2%	−0.4%
Iceland	7	0.062	0.881	0.880	0.880	0.878	−0.2%	−0.2%	−0.4%
Japan	8	0.118	0.855	0.848	0.849	0.837	−0.8%	−0.8%	−2.1%
Israel	9	0.088	0.844	0.840	0.840	0.836	−0.5%	−0.4%	−1.0%
France	10	0.058	0.883	0.881	0.881	0.880	−0.2%	−0.2%	−0.3%
Austria	11	0.085	0.866	0.862	0.862	0.859	−0.4%	−0.4%	−0.8%
Belgium	12	0.090	0.858	0.854	0.855	0.850	−0.5%	−0.4%	−1.0%
Finland	13	0.091	0.856	0.852	0.852	0.848	−0.5%	−0.4%	−1.0%
Italy	14	0.072	0.871	0.869	0.869	0.867	−0.3%	−0.3%	−0.5%
Czech Republic	15	0.091	0.839	0.835	0.835	0.830	−0.5%	−0.4%	−1.0%
Estonia	16	0.167	0.788	0.771	0.776	0.740	−2.2%	−1.6%	−6.1%
Poland	17	0.070	0.832	0.830	0.830	0.828	−0.3%	−0.3%	−0.5%
United Arab Emirates	18	0.339	0.608	0.505	0.535	0.458	−16.9%	−11.9%	−24.6%
Chile	19	0.076	0.848	0.845	0.845	0.845	−0.3%	−0.3%	−0.3%
Argentina	20	0.045	0.809	0.808	0.808	0.809	−0.1%	−0.1%	−0.1%
Uruguay	21	0.094	0.845	0.841	0.841	0.843	−0.5%	−0.5%	−0.2%
Romania	22	0.054	0.801	0.800	0.800	0.801	−0.2%	−0.2%	−0.1%
Russian Federation	23	0.240	0.630	0.576	0.597	0.589	−8.6%	−5.4%	−6.5%
Malaysia	24	0.152	0.705	0.690	0.692	0.694	−2.2%	−1.8%	−1.5%
Venezuela	25	0.216	0.680	0.642	0.656	0.667	−5.7%	−3.6%	−2.0%
Costa Rica	26	0.133	0.836	0.827	0.828	0.834	−1.1%	−1.0%	−0.3%
Mexico	27	0.126	0.754	0.746	0.746	0.750	−1.1%	−1.1%	−0.5%
Sri Lanka	28	0.219	0.723	0.691	0.697	0.721	−4.4%	−3.7%	−0.3%
Brazil	29	0.096	0.785	0.781	0.781	0.784	−0.6%	−0.6%	−0.2%
Peru	30	0.116	0.770	0.763	0.762	0.768	−0.9%	−1.0%	−0.2%
Belize	31	0.113	0.800	0.794	0.793	0.799	−0.8%	−0.9%	−0.2%
Thailand	32	0.164	0.699	0.682	0.684	0.693	−2.4%	−2.1%	−0.9%
China	33	0.305	0.600	0.464	0.545	0.573	−22.8%	−9.3%	−4.6%
Algeria	34	0.252	0.654	0.596	0.619	0.645	−8.9%	−5.4%	−1.4%
Colombia	35	0.163	0.725	0.710	0.710	0.722	−2.0%	−2.1%	−0.4%
Ecuador	36	0.144	0.736	0.725	0.724	0.733	−1.5%	−1.6%	−0.5%
Dominican Republic	37	0.130	0.748	0.739	0.738	0.746	−1.2%	−1.3%	−0.3%
Indonesia	38	0.139	0.723	0.713	0.711	0.721	−1.4%	−1.6%	−0.3%
Botswana	39	0.113	0.733	0.727	0.725	0.731	−0.9%	−1.1%	−0.3%
Egypt	40	0.262	0.642	0.583	0.602	0.636	−9.3%	−6.3%	−1.0%
Bolivia	41	0.135	0.712	0.703	0.700	0.710	−1.3%	−1.6%	−0.3%
El Salvador	42	0.159	0.733	0.720	0.718	0.732	−1.8%	−2.1%	−0.2%
Philippines	43	0.152	0.714	0.702	0.698	0.712	−1.6%	−2.2%	−0.2%
South Africa	44	0.075	0.692	0.688	0.688	0.689	−0.5%	−0.5%	−0.4%
Morocco	45	0.227	0.644	0.611	0.611	0.640	−5.1%	−5.1%	−0.6%
Honduras	46	0.219	0.664	0.636	0.633	0.661	−4.1%	−4.7%	−0.4%
Nicaragua	47	0.215	0.682	0.656	0.652	0.680	−3.7%	−4.4%	−0.3%
India	48	0.175	0.684	0.667	0.665	0.682	−2.6%	−2.8%	−0.4%
Zambia	49	0.198	0.643	0.623	0.615	0.643	−3.1%	−4.4%	−0.1%
Bangladesh	50	0.227	0.650	0.621	0.615	0.649	−4.5%	−5.3%	−0.2%

Source: Authors based on World Bank WDI (2017, various years) and HDI Trends (UNDP, 2017, various years).

the HDI and the SHDI compared to the arithmetic mean. The two graphs show how the indexes perform quite differently when it comes to penalize heterogeneity. The geometric mean, corresponding to the HDI approach, penalizes dramatically some units, which have their overall performances almost canceled by the synthetic score. The SHDI, on the contrary, appears to be much more robust. Moreover, it is interesting to notice how the asymmetry of its distribution, which appears fatter in the bottom right part, confirms the goodness of this index, which is supposed to induce heavier penalizations for poorer countries (i.e. countries with lower overall achievements), given a fixed level of heterogeneity.

The lower part of Fig. 1 shows the behavior of the ESHDI compared to the arithmetic mean. Since the ESHDI appears to excessively penalize countries with poor performances in the environmental dimension, we also propose an improved version where the maximum value of the parameter e_i is limited to a fixed value $\lambda > 1$. To test this approach, we perform a sensitivity analysis that compared the results of 40 different simulations[15] over λ with the most used indexes. It is interesting to note that for $4 < \lambda < 6$ the results are consistent with the wHSDI and the sHSDI index proposed by Bravo (2015). For this reason, we decided to set $\lambda = 5$ in the present work.[16]

As expected, the graph for the ESHDI suffers from the same issues underlined for the geometric mean: the penalizations seem to be too heavy (Clark, 2014). This problem is easily solved using the "improved" version of this index, which unveils the flexibility of the MSI-based approach: as the *g(.)* function is improved, the index appears much more robust. The performances of the units in the last graph have their heterogeneity penalized according their performances in the

[15] To avoid bias in the comparison, we perform the sensitivity analysis using the same four dimensions as Togtokh and Gaffney (2010) and Bravo (2015).

[16] This is almost equivalent to two tons of carbon dioxide emissions per capita (Neumayer, 2012).

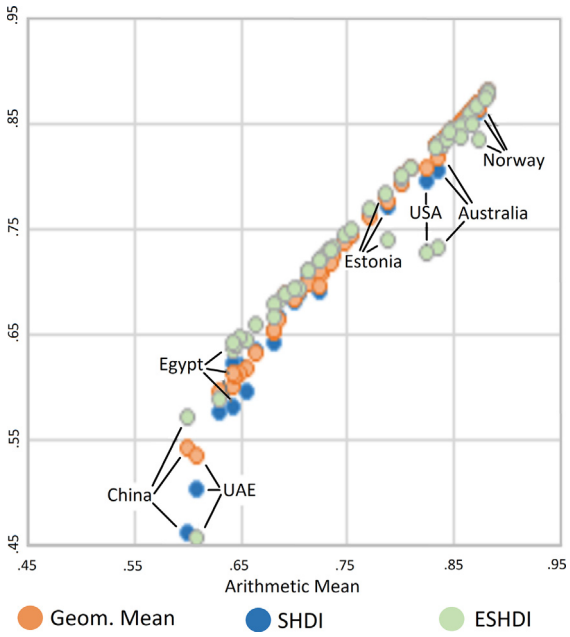

Fig. 2. Scatter of the comparison between Amean vs Gmean, SHDI and ESHDI. *Source*: Authors elaborations based on World Bank WDI (2017, various years) and on HDI Trends (UNDP, 2017, various years).

environmental dimension, and the decrease seems heavier for wealthy units. This is in line with the current literature (Togtokh and Gaffney 2010; Togtokh, 2011; Bravo, 2014, 2015; Clark, 2014).

5. Results and discussion

In this section, we calculate the HDI, the SHSI and the ESHDI in its improved version to real data, presenting the results of an empirical analysis based on the five dimensions and a sample of 50 countries.

The five dimensions analyzed are measured for the 50 countries using cross-sectional data from 2013. The outcomes are intended as opportunities to live in a country with high level of GNI, Education, Life Expectancy, clean air (free from CO_2 emissions) and freedom (political and civil liberties rights). Each variable is normalized using the HDI method as specified in the previous section.[17] Table 1 reports the basic descriptive statistics of the normalized values.

Table 2 reports the results for the 50 countries we have selected sorted by the standard HDI scores. The arithmetic mean produces perfect substitutability between dimensions, and therefore does not penalize heterogeneity, while the geometric mean (Gmean), the SHDI, and the ESHDI produce lower scores. As the table shows, these indexes produce similar results among countries with low heterogeneity: since the achievements are homogeneous, the hypothesis of perfect substitutability is acceptable, and both the geometric mean and the SHDI produce results that are similar to the arithmetic mean. For each index, the magnitude of the decrease with respect to the arithmetic mean is reported in percentage terms in the last three columns. The three indexes present significant differences for most countries.

As the standard deviation of the achievements increase, the assumption of perfect substitutability appears to be less credible. Countries with higher variability (U.A.E., U.S.A., Botswana, China, Russia, South Africa, and Norway) are penalized by both the geometric mean and the SHDI. The penalization that emerges because of the geometric mean is a function of the heterogeneity of the achievements only (i.e. the variation between the different indicators), while the penalization that characterizes the SHDI is also associated with the different levels of well-being in each country. The SHDI penalizes less countries with higher aggregate scores of human development with respect to the geometric mean. The SHDI is sensitive to aggregate development levels as lower scoring units are penalized more than higher scoring units. In particular, the USA, which has a medium-high degree of variability, is significantly penalized by the geometric mean (−3.4%), while the penalization induced by the SHDI is lower (−2.0%). This is due to the high level of overall well-being in USA, thus reinforcing the assumption that when development levels are low, the need for synergy between dimensions is higher. The penalization induced by the geometric mean appears excessively sensitive (for example China −22.8%) in presence of extremely deprived dimensions (this is due to the functional form of the index that is too sensitive to low values as in the case of Freedom for China and Egypt). In such situations the SHDI appears to be more robust, as values close to zero do not impact so heavily on the final results.

The ESHDI penalizes more than Gmean and SHDI in those countries with high CO_2 emissions such as rich countries (e.g. USA) and oil producing countries (e.g. United Arab Emirates). The ESHDI produces stronger change in the results. In fact, Table 2 shows that countries that perform badly in the environmental dimension are heavily penalized, including UAE (−24.5%), Australia (−12.3) and the USA (−11.6%).

These comparisons can be represented in a scatter diagram (Fig. 2). Each dot represents a country, and its overall achievements measured by the Arithmetic mean (x axis) and the three indexes analyzed (y axis).

Table 3 reports the ordinal rankings produced by each index. For instance, Norway ranks 1st according to the geometric mean, but comes in 6th when SHDI is used and 14th with the ESHDI. Australia ranks 2nd but moves to 18th position with the SHDI and to 27th with the ESHDI. Similar outcome patterns are reported for the USA, UAE, Venezuela, China, Malaysia, and Algeria. In particular, the Russian Federation falls by 25 places from 23rd to 48th out of 50 countries.

In other words, the ESHDI produces stronger changes in the ranking. Countries that are performing badly in CO_2 emission are thus the most punished, while countries that perform well in environmental terms gain several places. These include developing countries such as El Salvador (+14), Sri Lanka and Dominican Republic (+13), Costa Rica and Belize (+11), Botswana, Ecuador, Uruguay (+10), and from countries such as Italy, Chile and France (+9).

To further analyze the significance of the differences found, we have performed a comparison between the HDI and the SHDI using the three standard variables by themselves. The results are similar, and the final ranking is almost the same (as 48 out of 50 countries do not change places in the ranking – see the Appendix at the end of the paper). As expected, this confirms the hypotheses that the SHDI is consistent with the HDI when the number of variables included is limited; and that it performs better than the HDI as the number of dimensions included the analysis expand.

6. Conclusions

This paper has made three main contributions to the HDI debate.

The first involves the proposal of integrating sustainability issues into the HDI via the introduction of new dimensions that address environmental concerns (carbon emissions) and negative freedom (political rights and civil liberties). The inclusions of the environmental and freedom dimensions help to complete the measurement of a SHD processes.

The second contribution is linked to the new method of aggregation that eliminates some well-known limitations of the geometric mean while maintaining the same desirable properties such as the penalization of heterogeneous outcomes, which is also known as “prioritization” (Klugman et al, 2011). This method of aggregation assigns higher scores

[17] The levels used for this transformation was set at approximately 10% less (more) than the observed minimum (maximum).

Table 3
Rankings, HDI, SHDI and ESHDI (year 2013).

Country	R_HDI	R_Gmean	R_SHDI	R_ESHDI	Diff Geom	Diff SHDI	Diff ESHDI
Norway	1	7	6	14	-6	-5	-13
Australia	2	19	18	27	-17	-16	-25
Netherlands	3	8	8	8	-5	-5	-5
United States	4	21	20	30	-17	-16	-26
New Zealand	5	4	4	4	+1	+1	+1
Denmark	6	3	3	3	+3	+3	+3
Iceland	7	2	2	2	+5	+5	+5
Japan	8	11	11	12	-3	-3	-4
Israel	9	14	14	13	-5	-5	-4
France	10	1	1	1	+9	+9	+9
Austria	11	6	7	6	+5	+4	+5
Belgium	12	9	9	7	+3	+3	+5
Finland	13	10	10	9	+3	+3	+4
Italy	14	5	5	5	+9	+9	+9
Czech Republic	15	15	15	16	0	0	-1
Estonia	16	24	24	25	-8	-8	-9
Poland	17	16	16	17	+1	+1	0
United Arab Emirates	18	49	50	50	-31	–32	–32
Chile	19	12	12	10	+7	+7	+9
Argentina	20	18	19	18	+2	+1	+2
Uruguay	21	13	13	11	+8	+8	+10
Romania	22	20	21	19	+2	+1	+3
Russian Federation	23	48	48	48	-25	-25	-25
Malaysia	24	36	36	36	-12	-12	-12
Venezuela	25	41	40	41	-16	-15	-16
Costa Rica	26	17	17	15	+9	+9	+11
Mexico	27	26	26	23	+1	+1	+4
Sri Lanka	28	35	35	32	-7	-7	-4
Brazil	29	23	23	21	+6	+6	+8
Peru	30	25	25	22	+5	+5	+8
Belize	31	22	22	20	+9	+9	+11
Thailand	32	38	38	37	-6	-6	-5
China	33	50	49	49	-17	-16	-16
Algeria	34	46	43	44	-12	-9	-10
Colombia	35	32	32	31	+3	+3	+4
Ecuador	36	29	29	26	+7	+7	+10
Dominican Republic	37	27	27	24	+10	+10	+13
Indonesia	38	31	31	33	+7	+7	+5
Botswana	39	28	28	29	+11	+11	+10
Egypt	40	47	47	47	-7	-7	-7
Bolivia	41	33	33	35	+8	+8	+6
El Salvador	42	30	30	28	+12	+12	+14
Philippines	43	34	34	34	+9	+9	+9
South Africa	44	37	37	38	+7	+7	+6
Honduras	45	42	42	42	+3	+3	+3
Morocco	46	45	46	46	+1	0	0
Nicaragua	47	40	41	40	+7	+6	+7
India	48	39	39	39	+9	+9	+9
Zambia	49	43	45	45	+6	+4	+4
Bangladesh	50	44	44	43	+6	+6	+7

Source: Authors based on World Bank WDI (2017, various years) and on HDI Trends (UNDP, 2017, various years).

(that penalize less) to countries with homogeneous levels in the measured outcomes (i.e. more synergic). The higher the level of development of a country (the average among the five dimensions), the lower is the heterogeneity of penalization. As the number of dimensions featured in the index increases, the SHDI – unlike the HDI – is able to maintain the balance between intuitive appeals of a human development orientated index and its explanatory power.

The third contribution is the introduction of the ESHDI, an index that allows us to control penalization due to heterogeneity among countries with low level of per capita CO_2 emissions.

Although the SHDI helps overcome the "inescapable arbitrariness" issue mentioned by Anand and Sen (1997), it still maintains some elements of subjectivity in terms of how the functional form of $g(\cdot)$ and its parameters are chosen. We do not claim to have solved the arbitrariness issue, but rather to have proposed an index that allows for a more flexible approach towards managing the relationships between various dimensions. In our opinion, the tools provided by this approach encourage a better understanding of the crucial dynamics that emerge while performing this type of synthesis. Even if a certain degree of arbitrariness remains inescapable, a deeper understanding and a more flexible approach can significantly increase the awareness and consciousness of these choices.

From a political and policy perspective, and from a practical point of view, SHD can be considered a policy objective for the 2030 Agenda for Sustainable Development, the UN system and, hence, for other international development agencies and most nations. Therefore, achieving high levels of SHD – i.e. HD compatible with strong environmental sustainability (Neumayer, 2012) and inclusion – is one of the major challenges facing humankind in implementing the 2030 Agenda.

Considering the increasing role of UNDP in the 2030 Agenda and in monitoring the SDGs, the SHDI could present a significant step forward for the HDRO and UNDP. Given that "What we measure affects what we do" (Stiglitz et al., 2009, p. 9), it is time to speed-up change so that the HDI can take account of sustainability in order to continue to provide a

relevant role in the development arena and to aligning itself to UNDP's SHD strategy.

Future research could consider how the SHDI and the ESHDI could be analyzed from a dynamic perspective by identifying SHD patterns, outcomes and performance within and between countries over time, and by considering the use of micro-data to include inequality within countries and to analyze local SHD performances.

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Appendix

Table A1 reports the comparison between the HDI (geometric mean) and the HDI (MSI method) using the three standard dimensions of HDI. The results are exceptionally similar (columns 4 and 5) and the final ranking is almost the same, as 48 out of 50 countries do not show any change in the rank. This confirms the hypothesis that the MSI method is consistent with the geometric mean when the number of variables is limited, while it performs better as the number of dimensions increases.

Table A1: The standard HDI with geometric mean and with MSI method ranks and value.

Country 2013	R_HDI_Geom	R_HDI_MSI	loss_R_MSI	HDI Gmean	HDI MSI
Norway	1	1	0	0.944	0.944
Australia	2	2	0	0.933	0.933
Netherlands	3	3	0	0.915	0.915
United States	4	4	0	0.914	0.914
New Zealand	5	5	0	0.910	0.910
Denmark	6	6	0	0.901	0.901
Iceland	7	7	0	0.895	0.894
Japan	8	8	0	0.890	0.890
Israel	9	9	0	0.888	0.887
France	10	10	0	0.885	0.885
Austria	11	11	0	0.881	0.881
Belgium	12	12	0	0.881	0.881
Finland	13	13	0	0.879	0.879
Italy	14	14	0	0.872	0.872
Czech Republic	15	15	0	0.861	0.861
Estonia	16	16	0	0.840	0.840
Poland	17	17	0	0.834	0.834
United Arab Emirates	18	18	0	0.827	0.827
Chile	19	19	0	0.821	0.821
Argentina	20	20	0	0.808	0.808
Uruguay	21	21	0	0.789	0.789
Romania	22	22	0	0.785	0.785
Russian Federation	23	23	0	0.778	0.778
Malaysia	24	24	0	0.773	0.773
Venezuela	25	25	0	0.764	0.764
Costa Rica	26	26	0	0.762	0.761
Mexico	27	27	0	0.756	0.756
Sri Lanka	28	28	0	0.750	0.750
Brazil	29	29	0	0.743	0.743
Peru	30	30	0	0.737	0.736
Belize	31	31	0	0.732	0.731
Thailand	32	32	0	0.722	0.722
China	33	33	0	0.719	0.719
Algeria	34	34	0	0.717	0.717
Ecuador	35	36	-1	0.711	0.710
Colombia	36	35	1	0.711	0.711
Dominican Republic	37	37	0	0.700	0.700
Indonesia	38	38	0	0.684	0.684
Botswana	39	39	0	0.683	0.683

Egypt	40	40	0	0.682	0.682
Bolivia	41	41	0	0.668	0.668
El Salvador	42	42	0	0.661	0.661
Philippines	43	43	0	0.660	0.659
SouthAfrica	44	44	0	0.657	0.658
Morocco	45	45	0	0.617	0.618
Honduras	46	46	0	0.617	0.615
Nicaragua	47	47	0	0.614	0.612
India	48	48	0	0.586	0.586
Zambia	49	49	0	0.561	0.561
Bangladesh	50	50	0	0.558	0.556

Source: Authors based on data from World Bank WDI (2017, various years), Freedom House (2017, various years), and HDI Trends UNDP (2017, various years).

Table A2. reports the calculation using four dimensions: the standard three dimensions of HDI plus the environmental dimension. The data reported compare the ranks between the SHDI, the ESHDI throughout the arithmetic mean wHSDI (Togtokh and Gaffney, 2010), and sHSDI (Bravo, 2015). The ranking of standard HDI with three dimensions is reported in the first column for comparison.

Table A2. Comparison between Geometric mean (HDI) i.e. without environment, the SHDI, and the ESHDI throughout the arithmetic mean wHSDI (Togtokh and Gaffney, 2010) R_sHSDI Bravo (2015).

Country 2013	R_HDI	R_SHDI_4(HDI + E)	R_wHSDI	Dif_4	R_ESHDI_4	R_sHSDI	Diff_4
Norway	1	6	7	−1	15	39	−24
Australia	2	21	25	−4	43	47	−4
Netherlands	3	8	8	0	8	33	−25
United States	4	26	27	−1	45	49	−4
New Zealand	5	4	4	0	4	14	−10
Denmark	6	3	3	0	3	7	−4
Iceland	7	2	2	0	2	5	−3
Japan	8	12	12	0	13	34	−21
Israel	9	9	9	0	9	26	−17
France	10	1	1	0	1	1	0
Austria	11	7	6	1	6	16	−10
Belgium	12	10	10	0	7	23	−16
Finland	13	11	11	0	10	25	−15
Italy	14	5	5	0	5	6	−1
Czech Republic	15	16	16	0	17	37	−20
Estonia	16	34	35	−1	41	48	−7
Poland	17	17	17	0	19	31	−12
United Arab Emirates	18	45	46	−1	50	50	0
Chile	19	13	13	0	11	10	1
Argentina	20	15	15	0	14	12	2
Uruguay	21	14	14	0	12	2	10
Romania	22	18	18	0	18	9	9
Russian Federation	23	40	42	−2	39	46	−7
Malaysia	24	28	28	0	28	40	−12
Venezuela	25	27	26	1	25	32	−7
Costa Rica	26	19	19	0	16	4	12
Mexico	27	23	22	1	24	17	7
Sri Lanka	28	20	20	0	20	3	17
Brazil	29	22	21	1	22	13	9
Peru	30	24	23	1	21	11	10
Belize	31	25	24	1	23	8	15
Thailand	32	32	32	0	31	30	1
China	33	38	40	−2	38	44	−6
Algeria	34	31	31	0	30	24	6
Ecuador	35	30	30	0	27	19	8
Colombia	36	29	29	0	26	15	11
Dominican Republic	37	33	33	0	29	18	11
Indonesia	38	35	34	1	32	20	12
Botswana	39	36	36	0	35	27	8
Egypt	40	37	37	0	33	28	5
Bolivia	41	41	39	2	37	29	8
El Salvador	42	39	38	1	34	21	13

Philippines	43	42	41	1	36	22	14
SouthAfrica	44	47	47	0	48	45	3
Morocco	45	43	43	0	42	36	6
Honduras	46	46	45	1	44	38	6
Nicaragua	47	44	44	0	40	35	5
India	48	48	48	0	46	42	4
Zambia	49	50	49	1	49	41	8
Bangladesh	50	49	50	−1	47	43	4

Source: Authors based on data from World Bank WDI (2017, various years), Freedom House (2017, various years), and HDI Trends UNDP (2017, various years).

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