1 Augmented *Human Development: What Is It? How to Measure It?*

1.1 Introduction

Human development is defined as 'a process of enlarging people's choices', which includes enjoying a healthy life, acquiring knowledge, and achieving a decent standard of living (United Nations Development Programme [UNDP], 1990: 10; 1993: 105). But how can we move from an abstract concept to an empirical measure? This chapter provides an answer to this question and implements an empirical measure, the *Augmented* Human Development Index. The chapter consists of three substantive sections. Section 1.2 discusses the measurement of human development, examining each of its dimensions and exploring their proxies. Section 1.3 offers an *augmented* human development index [*AHDI*] that differs from the conventional human development index [*HDI*] by virtue of a non-linear transformation of its health and education variables and the addition of a new dimension: political and civil rights as a way of incorporating freedom of choice.[1] Section 1.4 compares the resulting *AHDI* with alternative specifications of the index. The time span covered by the *AHDI* runs from the late nineteenth century, when human welfare was being widely affected by improvements in global health and education, to the aftermath of the 2008 Great Recession.[2] Its geographical coverage ranges from 115 to 162 countries that represent most of the world population.

1.2 Human Development: From Concept to Measure

Shifting from the conceptual to the practical level when considering human development presents a challenge. In order to provide a synthetic measure of human development, proxies for its different dimensions need to be chosen from among the array of available objective measures. In the UNDP's *HDI*, a healthy and long life is proxied by life expectancy at birth; access to knowledge, by years of schooling; and

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command over resources needed for a decent living standard, by the logarithmic transformation of per capita income.

An important distinction exists between longevity and education, on the one hand, and per capita income, on the other. The former are measures not only of achievement but also of capability: namely, avoiding premature death or ignorance. This is not true of the latter. Per capita income is not the ultimate objective for individuals; it simply represents an input that can be turned into a capability: being able to live a full, meaningful life. This implies that being able to command resources is one ingredient in an individual's ability to lead a freer life. That is why per capita income enters the index at a declining rate, since, in terms of capabilities, its return diminishes as its level rises (Anand and Sen, 2000: 100). In the *HDI*, the transformed income index is also intended to provide a surrogate for well-being dimensions aside from health and knowledge (Anand and Sen, 2000: 99).

Although conceptually unaltered, the composition of the *HDI* has varied over time. In 2010, the *Human Development Report* introduced major changes in the indicators used to represent two of the dimensions of human development (UNDP, 2010). For education, the expected years of schooling for a school-age child and the mean years of schooling among the population aged 25 and older were combined using an unweighted arithmetic average (UNDP, 2014).[3] In the case of income, purchasing-power-parity (PPP) adjusted per capita Gross National Income (GNI) replaced PPP-adjusted GDP per head. This represented an improvement, as GNI captures the income accruing to residents of a country, not just the income produced in the country irrespective of the share retained at home. In health, measured by life expectancy at birth, no changes were made.

In order to homogenise the indicators for the different dimensions, their original values (I) are transformed into an index in the form of

$$I = (x - M_o)/(M - M_o), \qquad [1.1]$$

where x is the observed value of a given dimension of welfare, and M_o and M are the minimum and maximum values, or goalposts, to facilitate comparison over time. Each dimension therefore ranges between 0 and 1.

New goalposts were introduced by the UNDP in 2014, replacing those defined in 2010.[4] For life expectancy at birth, the maximum and the minimum values were established at 85 and 20 years, respectively.

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For education, maximum values were set at 15 for the mean years of schooling among the adult population and 18 for the expected years of schooling for a school-age child, with the minimum set at 0 for both indicators. For GNI per capita, the maximum and minimum were established at 75,000 and 100 purchasing-power-parity adjusted (PPP) 2011 dollars.[5]

An unweighted geometric average of all three dimensions (longevity, education, and income) is used to derive a synthetic human development index, replacing the arithmetic mean used until 2010. This approach is an attempt to reduce the substitutability between its different dimensions, to penalise low and uneven achievements, and to portray each dimension as equally indispensable. Thus, the UN index is calculated as:

$$HDI = \left(I_{Life\ Expectancy} \cdot I_{Schooling} \cdot I_{Adjusted\ Income}\right)^{1/3}. \qquad [1.2]$$

The human development index has drawn criticism since its inception (Srinivasan, 1994). The lack of foundations in welfare economics has been highlighted as its main shortcoming (Dowrick *et al.*, 2003: 502), even though the *HDI* was explicitly defined as a measure of wellbeing in terms of capabilities, not utility. Some of the main criticisms are addressed here.[6]

1.2.1 Longevity and Education

The transformation of the original values of social dimensions (life expectancy, height, literacy, schooling years) into index form presents a challenge. Social variables are often used in their raw form (Acemoglu and Johnson, 2007; Hatton and Brey, 2010; Lindert, 2004; Morrison and Murtin, 2009). Nevertheless, the fact that these non-income variables are bounded raises concerns about the use of their original values to make comparisons over space and time.

In the *HDI*, the linear transformation of the indicators for the social dimensions reduces the size of the denominator by introducing maximum and minimum values (goalposts) and thus widens the index's range (see equation [1.1]). However, the values assigned to the goalposts have been challenged as being discretionary. For example, Carmen Herrero et al. (2012: 54–55) reject the use of arbitrarily fixed minimum values that, they claim, penalise poorer performers and may determine countries' ranking. They instead recommend expressing each dimension x as a share of some maximum set value, M.

$$I = x/M \tag{1.3}$$

It can be argued, nonetheless, that as a natural floor often exists, lower goalposts simply aim at capturing subsistence levels. For example, historical evidence of life expectancy at birth indicates that 20 years was most probably a floor in human societies dating back to Neolithic times (Fogel, 2009: 13; Steckel, 2009: 34). This is also the case for per capita income, as human life cannot survive below a basic level of physiological subsistence (Milanovic *et al.* 2011: 262).[7]

However, when linearly transformed social variables (as in both the UNDP's *HDI* and Herrero *et al.*'s (2012) proposal) are used to compare countries (or time periods), identical absolute changes result in a smaller proportional improvement for the country (time period) with the higher starting level (as would also be the case if we were using their original values). Consider, for example, a 10-year improvement in life expectancy at birth, in one case, from 30 to 40 years, and in another, from 70 to 80 years. Although these changes are identical in absolute terms, the second is smaller relative to the initial level. Placed in the index for health used in the 2014 UN *HDI*, the first country would see a 100 per cent improvement from 0.15 to 0.31, while the second would see a 20 per cent improvement from 0.77 to 0.92. Therefore, a linear transformation does not solve the problem of the comparability of bounded social dimensions across countries or over time.

For health, there is a further problem. In poor countries, the main reduction of mortality takes place among children, as infectious disease declines, whereas in rich countries, mortality falls among the elderly as a result of better treatment of cardiovascular and respiratory diseases. Thus, if minimum original values of life expectancy at birth are employed and absolute changes of the same magnitude therefore receive a larger weight when the starting level is lower, the index will arbitrarily give more weight to saving the lives of younger people than the lives of older people (Deaton, 2006: 9).

The limitations of linearly transformed measures become more evident when quality is taken into account. Life expectancy at birth and years of schooling are just crude proxies for the actual goals of human development: a long and healthy life and access to knowledge. Unfortunately, data on health-adjusted longevity, 'healthy life

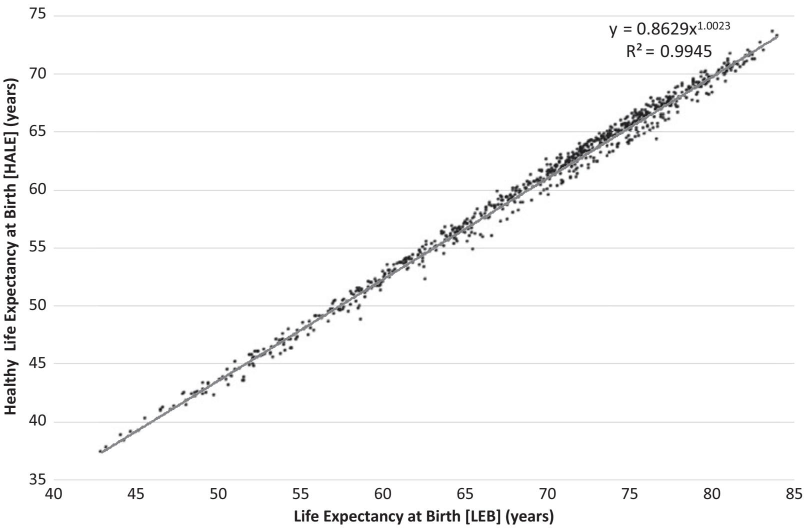

Figure 1.1 Healthy life expectancy at birth (HALE) and life expectancy at birth (LEB), 1990–2016.
Note: Pool of 1990, 2000, 2006, and 2016 benchmarks.
Sources: *Global Burden of Disease Study* (2016) in Murray et al. (2017).

expectancy', that is, a summary measure of health computed using age-specific death rates and years of life lived with disability per capita (Murray et al., 2017), have only existed since 1990. Reassuringly, the Global Burden of Disease Study 2016 allows us to compare healthy life expectancy at birth (HALE) with conventional life expectancy at birth (LEB) for the period 1990–2016. This shows that healthy life expectancy at birth rises with raw life expectancy at birth (Figure 1.1).[8]

The available evidence for the last three decades indicates that, although morbidity increased in absolute terms, it underwent a relative compression: the proportion of years lived in disability fell (Murray *et al.*, 2017). As life expectancy rose, disability for each age-cohort declined (Mathers *et al.*, 2001; Salomon *et al.* 2012; Murray *et al.*, 2017). More specifically, longer lives – due to a rapid decline in years of life lost – together with a more modest age-adjusted decline in years lived with disability have led to lower age-standardised disability-adjusted life years rates across the board (Murray *et al.*, 2017: 1331). In other words, the quality of life improves for each age cohort as life expectancy at birth increases.[9] Thus, the apparent ethical-measurement conflict observed by

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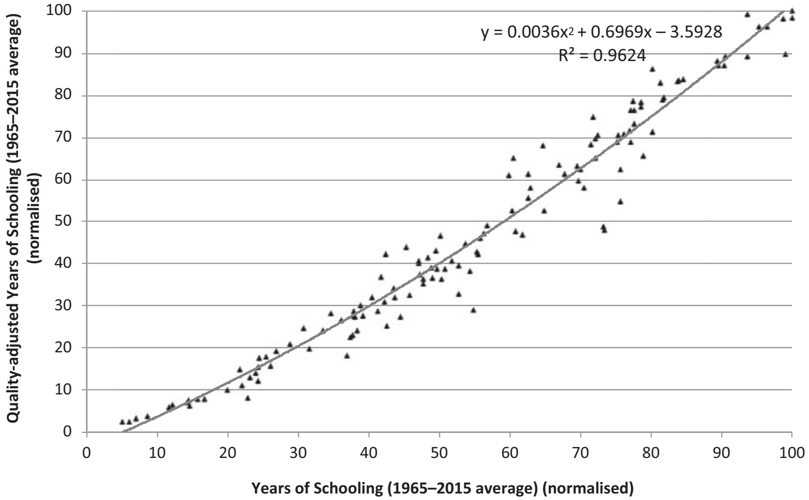

Figure 1.2 Quality-adjusted and raw years of schooling (1965–2015) (normalised).

Note: 1965–2015 average. Normalised (expressed relative to its maximum value).

Sources: Cognitive Skills, Altinok et al. (2018); years of schooling, see the text and Appendix A.

Partha Dasgupta (1990: 23) when he asserts, 'Equal increments are possibly of less and less ethical worth as life expectancy rises to 65 or 70 years and more. But we are meaning performance here. So it would seem that it becomes more and more commendable if, with increasing life expectancy, the index were to rise at the margin', fades away.

Similarly, the quality of education grows as the quantity of education increases. A comparison between quality-adjusted and quantity indices of education suggests a convex association between the two, with quality-adjusted education increasing more than proportionally at higher levels (Figure 1.2).[10]

To sum up, on the basis of the available evidence for the last decades, it can be claimed that more years of life expectancy and schooling imply higher quality of health and education, respectively, during childhood and adolescence. Hence, when transforming the original values of the health and education variables, one needs to allow for the fact that they are bounded and that their quality improves along with their quantity. The non-linear transformation proposed by Kakwani (1993) provides a means of achieving this.

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Using an axiomatic approach, Kakwani constructed a normalised index from an achievement function in which an increase in the standard of living of a country at a higher level implies a greater achievement than would have been the case had it occurred at a lower level:[11]

$$I = (\log(M - Mo) - \log(M - x)) / \log(M - Mo) \quad [1.5]$$

The same notation used in equation [1.1] applies: x is an indicator of a country's standard of living; M and Mo are the maximum and minimum values, respectively; and *log* stands for the natural logarithm. The achievement function proposed by Kakwani is a convex function of x. It is equal to 0 if $x = Mo$, and equal to 1 if $x = M$, ranging, thus, between 0 and 1.

The consequences of the Kakwani transformation of an original variable can be illustrated for a well-known empirical regularity such as the Preston curve, that is, the association between life expectancy and real per capita GDP proposed by Samuel Preston (1975). Figure 1.3a shows Preston's concave relationship between the original values of life expectancy at birth and real income per head; thus, initially, proportional increases in life expectancy correspond to increases in income but soon, that is, at relatively low income

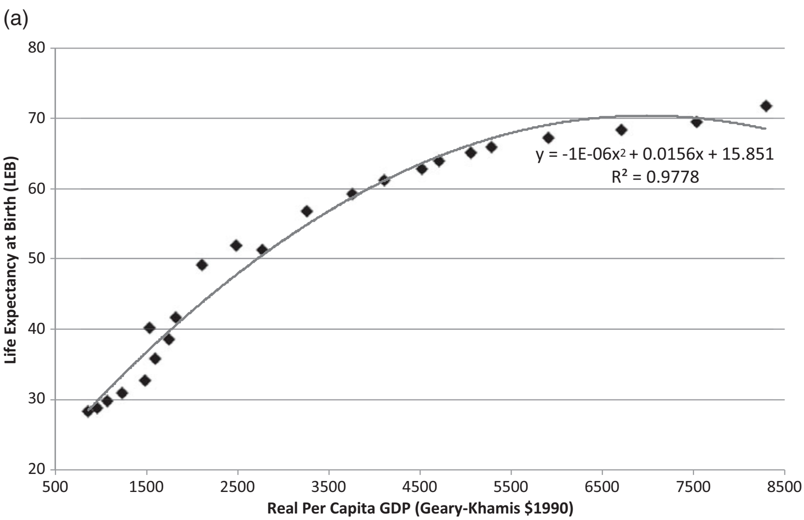

Figure 1.3a *Old* Preston curve, 1870–2015.
Sources: See the text and Appendix A

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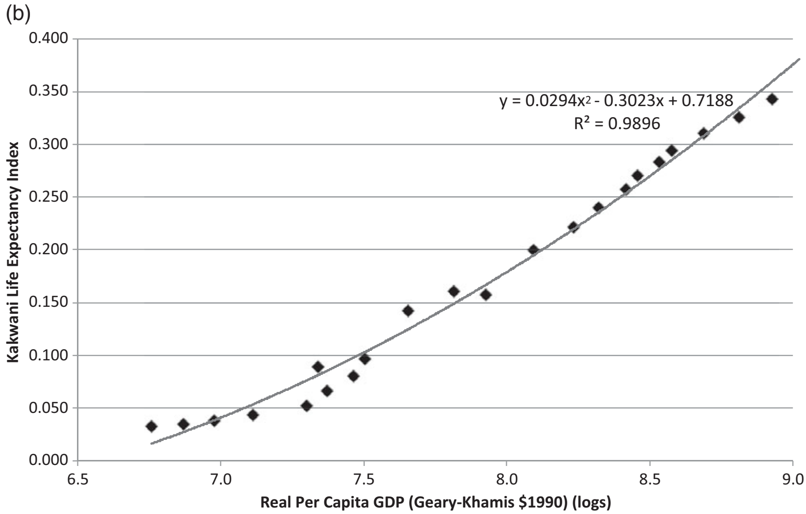

Figure 1.3b *Revised* Preston curve, 1870–2015.
Sources: See the text and Appendix A

levels – around Geary-Khamis 1990 $2,500, namely, the income per head in the UK by 1850 (Maddison Project Database, 2013) – the association flattens out, so successive increases in income imply less than proportional increases in life expectancy. Angus Deaton (2013) replicated the Preston curve, using the log of real GDP per head rather than its value to represent proportional changes, with the effect of reducing the concavity of the per capita income-life expectancy association. However, when a Kakwani convex transformation of the original values of life expectancy at birth is introduced, a linear relationship emerges between the life expectancy index and the log of real per capita GDP. This, at higher levels, shows convexity, suggesting that medical technology advances lead to more than proportional gains in health relative to income (Figure 1.3b).

How do the non-linearly transformed variables compare to their original, linearly transformed, values, or other approaches to transformation? For world average years of schooling and life expectancy at birth during 1870–2015, Table 1.1, cols. 2–6, presents, respectively, the non-linearly transformed (Kakwani) indices, alongside their conventional UNDP linearly transformed indices, and linear indices that present the share of maximum values, as suggested by Herrero,

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Table 1.1. *Alternative indices of years of schooling, life expectancy, per capita income, and liberal democracy, 1870–2015*

	Years of schooling		Life expectancy at birth			Per capita income					Liberal democracy
	Kakwani	UNDP	Kakwani	UNDP	HMV	UNDP	Bértola-Vecchi	Zambrano	HMV	HMV-eei	
1870	0.032	0.084	0.033	0.128	0.334	0.350	0.016	0.094	0.018	0.010	0.093
1880	0.037	0.096	0.036	0.138	0.341	0.368	0.018	0.102	0.020	0.012	0.102
1890	0.042	0.108	0.039	0.151	0.351	0.386	0.021	0.110	0.023	0.014	0.105
1900	0.048	0.123	0.045	0.170	0.365	0.408	0.024	0.121	0.026	0.015	0.115
1913	0.055	0.138	0.053	0.198	0.387	0.438	0.029	0.138	0.031	0.017	0.137
1925	0.063	0.158	0.067	0.244	0.422	0.450	0.032	0.145	0.034	0.017	0.161
1929	0.070	0.173	0.081	0.286	0.454	0.465	0.035	0.154	0.037	0.017	0.154
1933	0.076	0.186	0.090	0.312	0.474	0.444	0.031	0.141	0.033	0.015	0.144
1938	0.081	0.198	0.098	0.335	0.492	0.471	0.037	0.158	0.039	0.018	0.143
1950	0.094	0.225	0.143	0.450	0.579	0.496	0.043	0.174	0.045	0.020	0.208
1955	0.104	0.245	0.161	0.490	0.610	0.522	0.051	0.192	0.053	0.024	0.257
1960	0.115	0.267	0.157	0.482	0.604	0.540	0.057	0.206	0.059	0.026	0.262
1965	0.127	0.291	0.200	0.565	0.668	0.566	0.067	0.228	0.069	0.031	0.265
1970	0.141	0.317	0.222	0.604	0.697	0.589	0.078	0.248	0.080	0.035	0.254
1975	0.153	0.340	0.240	0.633	0.719	0.604	0.085	0.262	0.087	0.035	0.225
1980	0.169	0.368	0.257	0.658	0.738	0.619	0.094	0.277	0.096	0.042	0.267
1985	0.184	0.392	0.271	0.677	0.753	0.626	0.098	0.283	0.100	0.045	0.277
1990	0.194	0.409	0.283	0.693	0.765	0.638	0.106	0.296	0.108	0.048	0.331
1995	0.212	0.436	0.294	0.707	0.776	0.645	0.111	0.303	0.112	0.048	0.366
2000	0.229	0.462	0.310	0.726	0.791	0.663	0.124	0.323	0.126	0.049	0.392

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Table 1.1. (*cont.*)

	Years of schooling		Life expectancy at birth			Per capita income					Liberal democracy
	Kakwani	UNDP	Kakwani	UNDP	HMV	UNDP	Bértola-Vecchi	Zambrano	HMV	HMV-eei	
2005	0.244	0.483	0.325	0.742	0.803	0.683	0.141	0.347	0.143	0.058	0.390
2010	0.257	0.502	0.342	0.760	0.817	0.702	0.158	0.371	0.160	0.072	0.398
2015	0.274	0.524	0.380	0.796	0.844	0.718	0.175	0.392	0.176	0.085	0.374

Sources: See the text.

Notes:

HMV, Herrero, Martínez, and Villar (2012). HMV-eei means HMV adjusted for inequality (*egalitarian equivalent income*) In the case of years of schooling, since the minimum goalpost is 0, the results of the HMV and the UNDP transformations are identical.

Transformation of social dimensions (life expectancy, years of schooling)

-UNDP, linear transformation (expression [1]), $I = (x - M_o) / (M - M_o)$

-Kakwani, convex transformation (expression [5]) $I = (\log (M - Mo) - \log (M - x)) / \log (M - Mo)$

-HMV (Herrero, Martínez, and Villar) (expression [3]) $I = x / M$

Transformation of per capita income

-UNDP, linear transformation (expression [1]) but with values in natural logarithms (ln), $I = (\ln x - \ln M_o) / (\ln M - \ln M_o)$

-Bértola et al. and Vecchi et al. (expression [1]), $I = (x - M_o) / (M - M_o)$

-HMV (expression [3]) $I = x / M$

-HMV-eei, expression [3]) $I = x / M$ but replacing per capita income, y, with the egalitarian equivalent income, $y^e = y * (1 - G)$, where y represents per capita income and G, the Gini.

-Zambrano (expression [6]), $I = (x^r - M_o{}^r) / (M^r - M_o{}^r)$, with $r = 0.5$ r (a fraction of per capita income growth that translates into capabilities) $0 < r < 1$

Transformation of liberal democracy

-linear transformation (expression [1]), $I = (x - M_o) / (M - M_o)$

x is the observed value of a given dimension of welfare, and M_o and M are the maximum and minimum values, or goalposts

Martínez, and Villar (2012) (HMV). These indices are computed using the UNDP 2014 maximum goalposts. In the case of schooling, the HMV index is, by construction, identical to the UNDP transformation, so it is not reported separately. It can be observed that the Kakwani indices show systematically lower values, but also faster growth.

1.2.2 Income

The UNDP use of the log of per capita income to proxy a decent standard of living has been challenged since the early stages of the *HDI*. One alternative proposal has been to use a simple linear transformation without logarithms (equation [1.1]), which would arguably add another equally valuable dimension of human development and avoid underestimating per capita differences across countries as their levels increase (Bértola et al., 2011: 3–4). Another suggestion has been to express countries' real per capita income as a percentage of an established maximum level (Gormely, 1995; Herrero et al., 2012: 258). Recently, Eduardo Zambrano (2017: 535) has proposed a way to normalise per capita without using the logarithmic transformation. Unlike the social dimensions (health and education) of the *HDI*, for which a growth in the level achieved causes a proportional increase in terms of capabilities, Zambrano claims that per capita income growth translates less than proportionally in terms of capabilities; namely, in a fraction of it (r), with r varying within 0 and 1 and being the same for all income levels:

$$I = (x^r - {M_o}^r)/(M^r - {M_o}^r), \qquad [1.6]$$

In the particular case of $r = 0$, the result is the UNDP log transformation of income. However, as the value assigned to r is largely discretionary, an element of arbitrariness is introduced in the estimates.

The alternatives to the logarithmic transformation of per capita income (with the exception of Zambrano's proposal) do not address the very different nature of income compared to the other dimensions in the *HDI*, which are bounded in the cases of longevity and education, and without a known upper limit in the case of real per capita income. Although the convex transformation of the indicators of longevity and education dimensions mitigates the difference between these bounded variables and unbounded variables such as GDP per capita, it does not put them on a level playing field, and some form of compression of the income dimension of human development is required to make it comparable to its social dimensions (Sagar and Najam, 1998: 254).[12] Furthermore, the logarithmic transformation of average income may be interpreted as a multiple of the subsistence level, M_o, that is, in terms of the size of the income gap, M/M_o, to be bridged by a country whose average income is at subsistence level (Zambrano, 2014).[13] Therefore, although a logarithmic transformation of per capita income, as employed in the *HDI*, is a second-best solution, I have adopted it here in the absence of a superior alternative.[14]

Table 1.1, cols. 7–11, presents indices of real per capita income for the world between 1870 and 2015. It shows the conventional UNDP log-linear transformed index, along with four of the different alternatives that have been suggested: an index employing the linear but non-logarithmic transformation, as proposed by Bértola *et al.* (2011: 3–4) and Vecchi et al. (2017: 468) [*Bértola-Vecchi*]; an index expressing each country's average incomes as a share of an upper bound – here defined as the UNDP's 2014 maximum goalpost, 75,000 dollars – as suggested by Herrero et al. (2012) [*HMV*]; an index based on a further adjustment also proposed by Herrero *et al.* (2012) [*HMV-eei*], the *egalitarian equivalent income*, y^e, derived as $y^e = y^*(1 - G)$, where y represents per capita income and G represents the Gini;[15] and finally an index based on the non-logarithmic transformation proposed by Zambrano, here with an r value of 0.5.[16] It can be observed that compared to the UNDP logarithmic transformation, these indices exhibit much lower levels and higher growth rates, which imply larger differences across countries and over time.

1.2.3 Freedom

An objection to the choice of *HDI* components has been the absence of an equality dimension.[17] Since 2010, the *Human Development Report* has included an inequality-adjusted index, but a dearth of reliable historical data on inequality for most countries of the world precludes the use of this approach here.[18]

A more relevant issue is that, so far, attempts to portray human development in index form have only been made in terms of achievements or functionings.[19] However, the ability to choose between alternative bundles of functionings, a defining feature of human development as a measure of capabilities, is not considered in the *HDI*. But without

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agency – that is, the ability to pursue and realise the goals a person has reason to value – and freedom, any index falls short of being even a reduced-form measure of human development and simply becomes another 'basic needs' metric (Ivanov and Peleah, 2010: 17–18). However, attempts to incorporate agency and liberty into the *HDI* have been discouraged by threats from totalitarian countries (Klugman *et al*., 2011: 265).

Unlike inequality, for which no comprehensive historical data are available, the inclusion of freedom into a historical human development index is feasible. Dasgupta and Weale (1992: 120–122) added civil and political rights to a set of demographic and educational indicators in order to provide a comprehensive view of well-being, and Crafts (1997b: 621–622) expanded the exercise to Britain and other Western European countries during the Industrial Revolution. More recently, Bértola *et al*. (2011: 5) and Vecchi *et al*. (2017: 475–480), respectively, have added democratisation and political and civil rights as a fourth dimension to their *HDI* historical estimates.

Agency and freedom cover a wide range of capabilities, from civil to economic and political liberties, for which unfortunately there is not enough comprehensive data at a global level over the past 150 years. A partial solution is to consider a variable representing political and civil liberties.

One practical issue is the choice of the variables that may serve to proxy political and civil liberties. *Varieties of Democracy* [*V-Dem*], the latest and most complete database encompassing 201 countries from 1789–2018, provides a *Liberal Democracy Index*, which combines electoral democracy (including free competition, extensive participation, freedom of expression, and rulers' responsiveness to citizens), a collective and positive freedom, with a 'liberal' component concerning the protection of individual and minority rights (including civil liberties, the rule of law, an independent judiciary, and effective checks and balances that place limits on government), that is, a measure of negative freedom (Coppedge *et al*., 2018). The *Liberal Democracy Index* is more comprehensive than historical indices such as Polity IV Project's *Polity2* index and Vanhanen's *Index of Democratisation*.[20]

Table 1.1 (last column) shows the evolution of civil and political rights proxied by the population-weighted index of liberal democracy in the world since 1870.

1.2.4 A Composite Index

The decision to aggregate the different dimensions of human development into a synthetic index has provoked adverse reactions. Ravallion (2012a, 2012b) argued against the use of composite indices due to their limited theoretical underpinning and implicit trade-offs. The alternatives that have been suggested include addressing each dimension's indicator separately (Aturupane *et al.* 1994), resorting to a 'dashboard' of indicators (Ravallion, 2012a), and producing an ordinal, rather than a cardinal, measure (Dasgupta and Weale, 1992). In defence of an aggregate index of well-being, it has been argued that summarising a set of indicators into a single number avoids the risk of divergence between different well-being dimensions and offers an alternative to per capita income (Krishnakumar, 2018). Furthermore, it could be argued that in so far as human development is a latent unobservable variable, the composite index captures more information than its components individually considered.

Two aspects of the process of aggregation have also been the focus of debate. First, the equal weighting given to the dimensions in the human development index has been questioned. Why should each dimension (longevity, education, and income) receive the same weight in the index over space and time? (See Hopkins, 1991: 1471; Kelley, 1991: 319.) A substantive objection to the use of fixed weights is that the relative values of the index components are not necessarily the same across countries (or individuals) or over time (Srinivasan, 1994: 240). Moreover, it has been argued that the weights used in the *HDI* are based on judgement rather than on welfare theory (Dowrick *et al.*, 2003: 503). However, the notion that each of the dimensions is equally essential in determining the level of human development is one of the main attributes of the concept (Desai, 1991; Sagar and Najam, 1998: 251). A technical test of the validity of this approach has been developed, based on applying Principal Component Analysis (PCA) to the *HDI*. PCA estimates the optimal weights for each *HDI* component over time by weighting attributes by their variance and, thus, allows one to establish whether the human development index attributes are redundant or add information on different facets of well-being.[21] Perhaps counter-intuitively, the results obtained from using PCA suggest stable one-third weights are appropriate for each dimension of the index, offering some support for the UNDP methodology (UNDP, 1993; Ogwang, 1994; Nguefack-Tsague *et al.*, 2011).

The second substantive debate about the aggregation of the dimensions of the *HDI* centres on the shift from additivity to multiplicativity of the index's components introduced in 2010 (UNDP, 2010). The reason for the change was that the assumption of perfect substitutability between dimensions implicit in the arithmetic average was deemed to be in flagrant contradiction with the notion that each dimension was equally crucial in determining the human development index. Substitutability among the components of the index could be restricted by using their geometric average (Desai, 1991: 356; Sagar and Najam, 1998: 252). Yet, even though the geometric average favours a more balanced combination of human development dimensions, it is less intuitive than the arithmetic average (Klasen, 2018: 8).

Several harsh criticisms of the multiplicative method of aggregation have been put forward (Ravallion, 2012b; Chakravarty, 2011; Anand, 2018). Significantly, Ravallion (2012b) attacks the implicit trade-offs between the new index's dimensions, measured by their marginal rate of substitution (MRS), claiming that, in comparison with the additive method, the new multiplicative method downgrades life expectancy, penalising poor countries.[22] The 2010 *HDI*, he argues, 'generates a steep income gradient in the index's implicit valuations of life expectancy and schooling' (Ravallion, 2012b: 206). In particular, the value assigned to longevity relative to average income rises with per capita income, reaching a value 17,000 times higher for the richest countries than for the poorest ones.[23] Ravallion's bottom line is that the embodied social values of the new *HDI* imply that we value longevity (or education) more in rich countries than in poor ones.[24] Thus, he suggests, the HDI's implicit trade-offs lead to the unacceptable conclusion that 'the most promising way to promote human development in the world would be by investing in higher life expectancy in rich countries' (Ravallion, 2012b: 208). In response to Ravallion's objection, it can be argued that, for rich countries, the high value of longevity in terms of income simply means that per capita income makes a negligible contribution to increasing capabilities (Klugman et al., 2011: 278–280).[25]

The move to employing a geometric average for the *HDI* has two further consequences that should be recognised. First, the combination of the logarithmic transformation of per capita income in this multiplicative framework makes the *HDI*, according to Zambrano (2014: 864), 'very conservative in allowing income to be transformed into capabilities at high income . . . and very aggressive in allowing capabilities to shrink as income losses take place at very low income levels'. In addition, the geometric mean gives the *HDI* a cardinal dimension that allows for comparison of its change over space and time (Herrero et al., 2012: 251).[26]

1.3 An *Augmented* Human Development Index

Having considered the issues at stake in the construction of a synthetic index to capture the dimensions of human development, I propose a historical index on the basis of a new world dataset of life expectancy at birth, years of schooling for population 15 and older,[27] per capita GDP,[28] plus a new dimension, political and civil liberties, represented by the *Liberal Democracy Index*, which aims to capture agency and freedom so that the resulting augmented human development index provides a crude measure of capabilities.

Gathering the best possible dataset represents a challenge, and the proxies used for a long and healthy life and access to knowledge, life expectancy at birth and years of schooling, are unavoidably crude (for details, see Appendix A). Data on life expectancy at birth for the period 1980–2015 come from the *Human Development Reports* (UNDP, 2010 and 2016), the World Bank's 'World Development Indicators for 1960–1975', and the United Nations' *Demographic Yearbook Historical Supplement* (United Nations, 2000) for the 1950s. Estimates for the pre-1950 era come mostly from Riley (2005b,c), Flora (1983), and national sources. However, for most OECD countries the Human Mortality Dataset www.mortality.org/ has been preferred, complemented with the Clio-Infra Dataset www.clio-infra.eu/, and the case of Latin America the OxLAD, now MoxLAD database (Astorga et al., 2003) has been mainly used.

Data on the average years of total schooling (primary, secondary, and tertiary) for population aged 15 and over, for 2015 and 2010, derive mostly from the *Human Development Reports* (UNDP, 2016, 2013). For 1870–2010, the Clio-Infra dataset www.clio-infra.eu/Indicators/AverageYearsofEducation.html provides the most comprehensive database that has been completed with estimates from Földvári and van Leeuwen (2014) for Europe, and Barro and Lee (2013) www.barrolee.com/ and Lee and Lee (2016) https://barrolee.github.io/BarroLeeDataSet/DataLeeLee.html

The *Liberal Democracy Index* provided by Varieties of Democracy [V-Dem] (Coppedge *et al.*, 2018) www.v-dem.net/en/ has been chosen as the best proxy for civil and political liberties. It merges the electoral democracy index that comprises freedom of association, expression, suffrage, and clean elections, and the liberal component index that includes equality before the law and individual liberty, judicial constraints on the executive, and legislative constraints on the executive.

GDP per head in 1990 Geary-Khamis dollars comes from the Maddison Project Database (2018) [MPD2018, MPD2013], completed with Maddison (2006, 2010) www.rug.nl/ggdc/historicaldevelopment/maddison/ and CEPAL (2009, 2017) http://interwp.cepal.org/ for Latin America since 1950, plus individual countries' historical national accounts. For sub-Saharan Africa, most estimates come from Prados de la Escosura (2012). Conference Board (2016) 'alternative' series have been accepted for China since 1950.

In designing the new *augmented* human development index, I accept the goalposts (maximum and minimum values) set in the 2014 *Human Development Report*, which replaced those in place since 2010.[29] For life expectancy at birth, the maximum and the minimum values are 85 and 20 years, respectively. For education, the maximum and minimum values of average years of total schooling (primary, secondary, and tertiary) are 15 and 0, respectively. For liberal democracy, 0 and 1 are the lower and upper bounds. In addition, arbitrary 'floor' values (values closer to their actual minimum levels than the minimum goalposts, which tend to be too extreme) have been adopted in order to allow the inclusion of countries for which no data exist in earlier periods and, at the same time, to avoid zero values in the variables transformed with equations 1.1 and 1.5. Thus, 25 years of life expectancy at birth, 0.1 years of schooling, and a value of 0.01 for liberal democracy have been used as 'floor' levels. Per capita GDP is expressed in Geary-Khamis (purchasing-power-parity) 1990 dollars (G-K 1990$, hereafter) to adjust for the difference in price level across countries, and the goalposts are set at $100 and $47,000, respectively.[30] I have assumed G-K 1990$ 300 equates to a basic level of physiological subsistence and use this value as an adequate 'floor' for income.[31] In general terms, the upward bias the 'floor' introduces for the poorest countries does not vary the overall picture.

Indices for education and life expectancy are obtained following Kakwani (1993), through a convex transformation as in equation

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[1.5]. In the case of political and civil liberties, a linear transformation (derived with equation [1.1]) has been adopted. The reason is that, unlike the other bounded variables considered here, the *Liberal Democracy Index* measures quality as well as quantity. Lastly, the adjusted per capita income index has been derived with equation [1.1], but with all its terms expressed in logs.

Then, following the 2014 *Human Development Report*, the indices for each dimension have been combined as an equally weighted geometric average using a modified version of equation [1.2], in which I_k represented the indices derived with Kakwani's non-linear (convex) transformation for longevity and education. The Augmented Historical Human Development Index [*AHDI*] is thus defined as:

$$AHDI = \left(I_{k\,Life\,Expectancy} \cdot I_{k\,Schooling} \cdot I_{Adjusted\,Income} \cdot I_{Liberal\,Democracy}\right)^{1/4} \quad [1.7]$$

Data constraints mean that the country coverage varies over the time span considered here. From 1870 onwards, 115 countries are considered, with the number rising to 121, 146, 161, and 162 countries in samples starting in 1913, 1950, 1980, and 1990, respectively. The countries in these samples represent over 90 per cent of the world population, and nearly 100 per cent since 1950 (the sources and procedures are presented in Appendix A). Regional and world averages for the original values of each variable have been transformed into indices for each dimension, and then combined to derive human development indices.

When the coverage of countries varies between the five regional and world samples, splicing was applied, using the more recent period, for which the coverage is larger, as the benchmark. Thus, the new series (Y^R) results from using the level provided by the series closer to the present (that has wider spatial coverage) at the year T in which the two series overlap (Y_T), and re-scaling the earlier series (X_t) with the ratio between the two series for the year (T) at which they overlap (Y_T/X_T):

$$Y^R{}_t = (Y_T/X_T)_* X_t \quad \text{for } 0 \le t \le T \quad [1.8]$$

Given that a range of researchers strongly oppose the use of a geometric average to combine the dimensions of human development in the *HDI*, it seems reasonable to compare the performance of indices obtained alternatively as arithmetic and geometric averages. Thus,

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Table 1.2. ***Multiplicative and additive*** **augmented** ***human development indices***

	Geometric mean	Arithmetic mean	Ratio geometric/arithmetic
1870	0.077	0.127	0.60
1880	0.084	0.136	0.62
1890	0.091	0.143	0.63
1900	0.100	0.154	0.65
1913	0.115	0.171	0.67
1925	0.132	0.185	0.71
1929	0.142	0.193	0.74
1933	0.144	0.188	0.77
1938	0.152	0.198	0.77
1950	0.193	0.235	0.82
1955	0.218	0.261	0.83
1960	0.225	0.269	0.84
1965	0.248	0.290	0.86
1970	0.262	0.302	0.87
1975	0.266	0.306	0.87
1980	0.291	0.328	0.89
1985	0.305	0.339	0.90
1990	0.328	0.361	0.91
1995	0.348	0.379	0.92
2000	0.369	0.399	0.92
2005	0.381	0.410	0.93
2010	0.396	0.425	0.93
2015	0.409	0.437	0.94

Sources: See the text.

I have also computed a version of the augmented index using an unweighted arithmetic average of its dimensions [$AHDI_a$], which implies increasing their substitutability:

$$AHDI_a = \left(\mathrm{I_{k}}_{\,Life\,Expectancy} + \mathrm{I_{k}}_{\,Schooling} + \mathrm{I}_{Adjusted\,Income} + \mathrm{I}_{Liberal\,Democracy}\right)/4 \quad [1.9]$$

The contrast between the arithmetic- and geometric-average indices for world AHD over 1870–2015 is visible in Table 1.2. Although both indices share the same trends, the geometric-average index has a lower initial level and faster growth.[32] This confirms the penalisation of low

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Table 1.3. Augmented *and* non-augmented *human development indices*

	AHDI	HDI	*AHDI*/HDI ratio
1870	0.077	0.072	1.06
1880	0.084	0.079	1.07
1890	0.091	0.086	1.05
1900	0.100	0.096	1.05
1913	0.115	0.108	1.06
1925	0.132	0.124	1.07
1929	0.142	0.138	1.03
1933	0.144	0.145	1.00
1938	0.152	0.155	0.98
1950	0.193	0.188	1.03
1955	0.218	0.206	1.06
1960	0.225	0.214	1.05
1965	0.248	0.243	1.02
1970	0.262	0.264	0.99
1975	0.266	0.281	0.95
1980	0.291	0.300	0.97
1985	0.305	0.315	0.97
1990	0.328	0.327	1.00
1995	0.348	0.342	1.02
2000	0.369	0.361	1.02
2005	0.381	0.378	1.01
2010	0.396	0.396	1.00
2015	0.409	0.422	0.97

Sources: See the text.

and uneven levels of dimensions when the geometric formula is used, a feature that is consistent with the indispensability of each dimension to human development.

Finally, it is worth comparing the new *AHDI* with a human development index constructed with identical transformed variables but excluding the liberties dimension (*HDI*). *AHDI* and *HDI* present a similar evolution and long-run growth, as can be observed in Table 1.3, but the *AHDI* shows slower progress in the interwar years, over 1960–1980, and since 2000, with the difference being substantial in the 1930s and 1960s, and a faster pace during the 1940s and 1950s and the last two decades of the twentieth century. However, given the unequal distribution of liberties across countries over time, we should expect large differences between the AHDI and the HDI in specific countries (regions) and periods.

1.4 A Comparison with Alternative Specifications of the Index

How does this new historical index (*AHDI*) compare to alternative specifications for a multiplicative human development index that incorporates political and civil liberties alongside the standard dimensions? Table 1.4 shows the *AHDI* alongside six other possible approaches to constructing the index. The first two historical indices are derived using the UNDP (col. 2) and Zambrano (col. 3) specifications for the three conventional dimensions (longevity, education, and income) plus the addition of the fourth dimension, political and civil liberties, as incorporated in the *AHDI*; these are labelled *UNDP* and *Zambrano*, respectively.[33] It is noticeable that the *AHDI* exhibits systematically lower levels than these alternative methodologies, as a result of the Kakwani transformation of the education and health dimensions, which also translates into faster growth over time. The *Zambrano* specification produces intermediate values that fall between the *UNDP* specification and the *AHDI*.

Four other alternative specifications are also presented. The *Bértola-Vecchi* specification (col. 4) is obtained using the UNDP linear transformation of the non-income dimensions and a non-log linear transformation of per capita income, as suggested by the Bértola *et al.* (2011) and Vecchi *et al.* (2017) 'extended' human development index.[34] The *HMV* (col. 5) specification results from taking on board Herrero *et al.*'s (2012) proposal to transform the original values of the human development dimensions by computing them as shares of maximum values.[35] Counter-intuitively, these two indices are highly coincidental with the *AHDI*, as the higher values for the transformed non-income dimensions in *Bértola-Vecchi* and *HMV* specifications offset the lower value for the transformed income dimension.

The fifth alternative specification (col. 6) corresponds to Bértola *et al.*'s full proposal, with a geometric average of Kakwani indices for life expectancy and years of schooling, and linear indices for per capita income (with no log transformation) and political and civil liberties, labelled *Bértola-Kakwani*.[36] Finally, the last alternative, labelled *HMV-eei* (col. 7), includes Herrero *et al.*'s (2012) 'newer' *HDI* components, which transform the original values of the human development

Table 1.4. ***Alternative*** **augmented** ***human development indices, 1870–2015***

	Prados de la Escosura	UNDP	Zambrano	Bértola & Vecchi	HMV	Bértola (Kakwani)	HMV-eei*
1870	0.077	0.137	0.098	0.063	0.083	0.036	0.072
1880	0.084	0.149	0.108	0.071	0.091	0.040	0.079
1890	0.091	0.160	0.117	0.077	0.098	0.044	0.086
1900	0.100	0.177	0.131	0.087	0.108	0.049	0.093
1913	0.115	0.201	0.151	0.102	0.123	0.058	0.105
1925	0.132	0.230	0.173	0.119	0.138	0.068	0.116
1929	0.142	0.244	0.185	0.128	0.146	0.074	0.120
1933	0.144	0.247	0.185	0.127	0.143	0.074	0.117
1938	0.152	0.258	0.197	0.136	0.152	0.080	0.125
1950	0.193	0.320	0.246	0.173	0.187	0.105	0.153
1955	0.218	0.356	0.278	0.199	0.212	0.122	0.173
1960	0.225	0.367	0.289	0.209	0.223	0.128	0.183
1965	0.248	0.396	0.316	0.233	0.245	0.146	0.199
1970	0.262	0.412	0.332	0.248	0.259	0.158	0.210
1975	0.266	0.414	0.335	0.254	0.263	0.163	0.209
1980	0.291	0.447	0.365	0.279	0.289	0.182	0.235
1985	0.305	0.463	0.380	0.291	0.301	0.192	0.246

1990	0.328	0.495	0.408	0.316	0.325	0.209	0.265
1995	0.348	0.520	0.430	0.334	0.344	0.224	0.277
2000	0.369	0.543	0.454	0.357	0.366	0.242	0.290
2005	0.381	0.556	0.469	0.375	0.383	0.257	0.306
2010	0.396	0.571	0.487	0.394	0.402	0.273	0.329
2015	0.409	0.579	0.497	0.406	0.413	0.287	0.344

Sources: See the text.

Notes:

HMV, Herrero, Martínez, and Villar (2012). HMV-eei means HMV adjusted for inequality (*egalitarian equivalent income*)

AHDI combines the social dimensions and per capita income with expression (7), $AHDI = (I_{k\ Health} \cdot I_{k\ Education} \cdot I_{Income} \cdot I_{Liberal\ Democracy})^{1/4}$

-Bértola-Vecchi and Zambrano use UNDP linear transformation of social variables (Table 1.1)

-UNDP, HMV, and HMV-eei (egalitarian equivalent income) use their own transformation of social variables and per capita income (Table 1.1)

-Bértola (Kakwani) combines the Kakwani transformation of years of schooling and life expectancy with Bértola-Vecchi transformation of per capita income (Table 1.1) dimensions (health, education, political and civil liberties) by computing their shares of maximum values, and adjusts per capita income for inequality, using the *egalitarian equivalent income* formula $y^e = y * (1 - G)$. It can be seen that my proposed *AHDI* specification produces higher values, with the absolute difference increasing as the levels get higher, even though their growth rates are similar, while the *Bértola (Kakwani)* specification presents the lowest level across time.

In conclusion, the different specifications for an augmented human development index share common trends. The *AHDI* proposed here uses a specification that results in an intermediate position among the alternative options offered for an index of augmented human development.

1.5 Conclusions

This chapter has presented an *augmented* human development index that combines achievements in terms of health, education, and material welfare in a context of freedom of choice, and therefore meets the conceptual requirements of the capabilities approach. The comparison with alternative indices shows how crucial it is from both a conceptual and an empirical perspective to introduce diminishing returns in per capita income. Moreover, it confirms that the new index of augmented human development provides a balanced intermediate position among the available alternative specifications.