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Millennium Development Goals: Measuring Progress towards their Achievement

SATYA R. CHAKRAVARTY and AMITA MAJUMDER

Satya R. Chakravarty is Professor of Economics in the Economic Research Unit, Indian Statistical Institute, Kolkata, India, and Amita Majumder is Professor of Economics in the Economic Research Unit, Indian Statistical Institute, Kolkata, India

Abstract The Millennium Development Goals are time-bound quantified targets for improving the human condition from different perspectives. Within each Goal several targets have been set, and to each target there corresponds one or more indicators. For each indicator we axiomatically characterize an index of perceived progress towards reaching the Goals such that it can be used for monitoring progress. We also present a composite index of progress, which allows the calculation of percentage contributions of progress made in different dimensions. This, in turn, enables us to identify the dimensions for which more progress is required, which is important from a policy perspective. We also provide an empirical illustration of the proposed indices using cross-country data for different indicators.

Key words: Millennium Development Goals, Targets, Indicators, Axioms, Indices, Characterization, Illustration

Introduction

Eight Millennium Development Goals (MDGs) were adopted at the United Nations Millennium Summit in September 2000 in order to improve the living conditions of the world population. The target period for achieving the Goals has been set at 2015. These Goals are the world's time-bound and quantified targets to:

- (a) eradicate extreme poverty (measured by the share of population surviving on less than US\$1 a day) and hunger;
- (b) achieve universal primary education;
- (c) promote gender equality and empower women;
- (d) reduce child mortality;
- (e) improve maternal health;
- (f) combat HIV/AIDS, malaria and other diseases;

- (g) ensure environmental sustainability; and
- (h) develop a global partnership for development.

These eight Goals are essentially centered on national targets for poverty, hunger, education, gender equality, health and environmental sustainability, but they also include targets for establishing an international trade and finance policy framework through global partnerships that favor development. Thus, these Goals, which are unique in their ambition, concreteness and scope, can be regarded as benchmarks for progress towards a vision of development. They reflect a vital commitment to promoting human well-being from a multidimensional perspective.¹ The values implicit in these Goals share the concept of human well-being underlying the human development index.

Since building human capabilities is fundamental to expanding human choices, we can also interpret these Goals in terms of: (i) functionings, which indicate attainments of different indicators of well-being; and (ii) capability, which is the ability to achieve (Sen, 1985, 1987, 1997). The capability approach emphasizes what a person can do and not what he/she can purchase as the ultimate metric of well-being. Functionings are closely approximated by income, literacy, life expectancy, housing, public goods, and so forth. In the capability-functioning framework, the MDGs can be regarded as being intended to ease the constraints on people's ability to make choices of functionings. More precisely, we can say that these targets are attempts to reduce the extents of capability failures.

Complete attainment of economic, social and cultural rights requires far more than achieving the MDGs. But achieving the Goals is an important step towards that end. However, "success will require sustained action across the entire decade between now and the deadline" (Annan, 2005). Although the MDGs originated in the United Nations, country-driven and nationally owned efforts are necessary for their achievement. Given that the Goals are ambitious, reflecting urgent need for fast progress on development, every poor country has to prepare a national strategy that addresses the issues. It needs to assess whether and how the Goals can be achieved within the target period and may have to redefine policy priorities. In other words, every national development strategy should formulate national policies required to achieve these Goals, monitor progress, identify key obstacles and eliminate them. Identification of new actions and resources may be necessary to reach the Goals. Evidently, the poorer the country, the greater are the challenges. By adopting specific time-bound quantified Goals, the MDGs provide a firm basis for progress, but sound monitoring will be required.

The aim of this paper is to axiomatically characterize a composite index of progress towards reaching the defined objectives, such that it can be used for tracking progress and formulating appropriate policies. To this end, we first characterize an index of perceived progress that gives a

normalized value of the extent of reduction in deprivation desired over the period for each indicator. Then we aggregate these desired reductions across indicators to assess overall progress.² The indicator-wise indices as well as the composite index satisfy a period consistency property, which demands that total improvement over the period concerned is the sum of improvements for any number of intermediate periods. This property enables us to monitor progress, on shorter time spans, for any indicator and also for the composite index.

Another attractive feature of the composite index is that it becomes helpful in calculating the percentage contributions made by different indicators to overall progress. Evidently, from a policy perspective the low contributing indicators of attainment require attention in order to increase contributions to achieve faster progress towards the Goals. This shows an important policy application of our index in diverse situations, and its usefulness as a planning tool for identifying the sources of low progress. It helps policy formulators to judge why their country has lower progress compared with other countries, to overcome relevant deficiencies and to reformulate the country's policy priorities. Clearly, according to this notion of policy recommendation, an assessment of overall progress becomes contingent on the implicit valuation of the index. However, an exercise of this type may be useful because the non-welfarist approach to policy analysis is becoming quite popular (Sen, 1985), and often policy is evaluated using specific forms of indices.

The methodology developed in the paper is then applied to cross-country data to examine the progress made during the period 1990–2000, and to assess the magnitude of further progress demanded over the period 2000–2015 to achieve the targets. The indicators for which the progress is rather low are also identified when the assessment of achieving the targets is made on a combined basis.

It may be mentioned that more than 100 countries and five regions (Africa, Asia and the Pacific, Latin America and the Caribbean, Arab States, Central Europe and Commonwealth of Independent States) have already published their MDG Reports (Millennium Project, 2005; see also Social Watch, 2005). Each report describes how to achieve the Goals, and represents a comprehensive and detailed strategy of concerned countries towards achieving the targets (for further discussion see Prabhu, 2005; Reddy and Heuty, 2005). However, the approach we adopt in this paper is axiomatic and analytic for judging the performance of a country during a subperiod, judging the level of efforts required to reach the targets and identifying the indicators showing low progress when judgment is made on a global³ basis.

The next section presents the axiomatic framework and investigates analytically the properties of the characterized indices. The third section provides the empirical illustration using cross-country data, while the final section presents the authors' conclusions.

Formal framework

The objectives of the MDGs are to address deprivations of well-being in many dimensions of life — income, food, literacy, life expectancy at birth, health, gender equality and environmental sustainability, and so forth. Each of these dimensions represents an attribute of well-being.

In the present context, an indicator corresponding to an attribute represents either the level of attainment or deprivation of the attribute. For the sake of convenience, here we have transformed some of the indicators representing attainments in terms of deprivations, so that a lower value means a better situation for all the indicators uniformly.⁴

Suppose there are n indicators. In a general set-up, the objective of the index of targeted progress for any indicator is to compare its insufficiency or deprivation at the base year with its targeted level of deprivation. That is, given the base year deprivation level for an indicator, the index is a measure of the extent of its perceived reduction to its targeted value. For instance, the intent of the first MDG is ‘to halve, by the year 2015, the proportion of people whose income is less than one dollar a day and the proportion of people who suffer from hunger’. Thus, if in a country in the base year (1990) $\theta\%$ of the population was in hunger and earning less than one dollar a day, then the corresponding targeted progress index compares θ with $\theta/2$ in an unambiguous way.

Let b_j^0 be the extent of failure or deprivation of indicator j in the base year t_0 . We denote the target period by t_T and the targeted value of deprivation for indicator j by $b_j^T \geq 0$. Since the possibility of reducing deprivations arises only if they are positive, we assume that $b_j^0 > 0$ for all j .

An index of targeted progress for indicator j towards reaching the defined objective in deprivation in the target year from its base year value is a real valued function $I(b_j^0, b_j^T)$ that associates a value to each $(b_j^0, b_j^T) \in (0, \infty) \times [0, \infty)$. Formally, $I: (0, \infty) \times [0, \infty) \rightarrow R^1$, where R^1 is the real line. Given b_j^0 , the base year failure in indicator j , $I(b_j^0, b_j^T)$ is a measure of the extent of reduction in deprivation sought, determined in an unambiguous way, for reaching b_j^T from b_j^0 .

We now propose the following axioms for an arbitrary index I .

- *Zero at Equality* (ZAE): $I(b_j^0, b_j^T) = 0$ if $b_j^0 = b_j^T$.
- *Normalization* (NOM): $I(b_j^0, 0) = 1$
- *Homogeneity* (HOM): For all $c > 0$, $I(cb_j^0, cb_j^T) = I(b_j^0, b_j^T)$.
- *Linear Monotonicity* (LIM): For any $\theta_j \geq 0$, $I(b_j^0, b_j^T) - I(b_j^0, b_j^T + \theta_j) = \theta_j \Phi(b_j^0)$, where $\Phi: (0, \infty) \rightarrow R_{++}^1$, the strictly positive part of the real line.

ZAE indicates that if the targeted level of deprivation for indicator j is same as its base year value, then I takes on the value zero. This is quite

reasonable. If the base year and target year levels of deprivation are the same, then a reduction in the extent of deprivation over the period is not desired at all and consequently the index value should be zero. According to NOM, if the targeted failure level for an indicator is set at its minimum level (zero), then the extent of desired progress is one.

The homogeneity property HOM means that I should be independent of the unit of measurement of indicator failures. Thus, if life expectancy is measured in months instead of in years, the index value remains unaltered.

Finally, LIM indicates that, if the targeted failure value is revised (increased) by an amount θ_j , then the extent of reduction in the targeted progress index resulting from this increase in b_j^T is given by the product of θ_j and a positive valued function of the base year failure b_j^0 . We can explain the relevance of this axiom using the UNDP (2006) deprivation function for indicator j , which is defined by $d_j = (M_j - x_j) / (M_j - m_j)$, where x_j is the attainment level of the indicator, and M_j and m_j are its upper and lower bounds, respectively. Now, suppose x_j is reduced by α_j so that the new level of deprivation is $d'_j = (M_j - (x_j - \alpha_j)) / (M_j - m_j)$. (Increasing failure is analogous to reducing attainment.) The resulting increase in deprivation is $d'_j - d_j = \alpha_j / (M_j - m_j) = \alpha_j \Psi(M_j, m_j)$ (say). This is essentially the same as LIM.

The following theorem identifies the index of progress satisfying axioms ZAE, NOM, HOM and LIM.

Theorem 1. The only index of progress $I: (0, \infty) \times [0, \infty) \rightarrow R^1$ that satisfies ZAE, NOM, HOM and LIM is given by

$$I(b_j^0, b_j^T) = \frac{b_j^0 - b_j^T}{b_j^0}. \tag{1}$$

Proof: LIM says that for any $\theta_j \geq 0$,

$$I(b_j^0, b_j^T) - I(b_j^0, b_j^T + \theta_j) = \theta_j \Phi(b_j^0). \tag{2}$$

Since $\theta_j \in [0, \infty)$ is arbitrary, we can interchange the roles of b_j^T and θ_j in Equation (2) and derive that

$$I(b_j^0, \theta_j) - I(b_j^0, \theta_j + b_j^T) = b_j^T \Phi(b_j^0). \tag{3}$$

Subtracting Equation (3) from Equation (2) we obtain

$$I(b_j^0, b_j^T) - I(b_j^0, \theta_j) = (\theta_j - b_j^T) \Phi(b_j^0). \tag{4}$$

Choosing $\theta_j = b_j^0$ in Equation (4), we have

$$I(b_j^0, b_j^T) - I(b_j^0, b_j^0) = (b_j^0 - b_j^T) \Phi(b_j^0), \tag{5}$$

which, in view of ZAE, becomes

$$I(b_j^0, b_j^T) = (b_j^0 - b_j^T) \Phi(b_j^0). \tag{6}$$

By HOM, I is homogeneous of degree zero in its arguments. The first bracketed term on the right-hand side of Equation (6) is linear homogeneous. Therefore, for I to be homogeneous of degree zero, it must be the case that $\Phi(b_j^0) = q/b_j^0$, where positivity of Φ demands that the constant $q > 0$.

Substituting the above form of Φ in Equation (6) and applying NOM, we note that q becomes one. Hence the resulting form of $I(b_j^0, b_j^T)$ coincides with Equation (1). This establishes the necessary part of the theorem. The sufficiency is easy to check.

When expressed in percentage form, I determines the percentage reduction in deprivation required to reach the targeted value b_j^T from its base year value b_j^0 .

As stated, for policy purposes it often becomes necessary to observe how much reduction in deprivation has been achieved during a given subperiod of the global period between the base year and the target year. For this we subdivide the global period $[t_0, t_T]$ into l subperiods $[t_0, t_1]$, $[t_1, t_2]$, ..., $[t_{l-2}, t_{l-1}]$ and $[t_{l-1}, t_T]$, where $l \geq 2$ is arbitrary. Assume that in addition to t_0 we have observed the levels of deprivation for indicator j at time points t_1, \dots, t_{l-1} and denote them by $b_j^i, i=1, 2, \dots, l-1$. Then $a_j^i = (b_j^i - b_j^{i+1})/b_j^0$ is the reduction in deprivation achieved, as a fraction of the base year deprivation, over the period $[t_i, t_{i+1}]$, $i=0, 1, 2, \dots, l-2$. Then we have

$$I(b_j^0, b_j^T) = \sum_{i=0}^{l-2} a_j^i + \frac{b_j^{l-1} - b_j^T}{b_j^0}. \quad (7)$$

We refer to this property of I as period consistency (PC). Thus, PC says that given the realized levels of normalized deprivation $a_j^i, i=0, 1, \dots, l-2$, $(b_j^{l-1} - b_j^T)/b_j^0$ is the extent of reduction in deprivation necessary over the period $[t_{l-1}, t_T]$ so as to reach the planned level of deprivation b_j^T . Hence this property becomes an important tool for policy analysis. More precisely, it enables us to monitor progress towards reaching the Goal. It dictates, given our achievements in diminishing failure in one or more subperiods of the global period, how much more of failure we need to reduce over the remaining subperiod to reach the targeted level of deprivation.

The index I is a summary measure of the desired level of reduction in deprivation between the base year and the target year for a particular indicator. An overall index should involve such information on all the indicators.

Assume that the overall index G , which is a summary statistic of the levels of decrements in deprivations sought across indicators, is a real valued function of single-dimensional indices. Such assumptions are made

in welfare economics, where social utility is regarded as a function of individual utility levels. In the human development literature, the Human Development Index (Human Poverty Index), which is an index of achievement (failure), is assumed to depend on individual attainment (deprivation) indicators (UNDP, 2006; Chakravarty, 2003; Chakravarty and Majumder, 2005).

Now, denote $I(b_j^0, b_j^T)$ by b_j , where $j=1, 2, \dots, n$. We write $b=(b_1, b_2, \dots, b_n)$. Then the relationship can be formally stated as: There exists a function $J:R^n \rightarrow R^1$ such that for all $((b_1^0, b_1^T), (b_2^0, b_2^T), \dots, (b_n^0, b_n^T))$, the global perceived failure reduction index $G((b_1^0, b_1^T), (b_2^0, b_2^T), \dots, (b_n^0, b_n^T))$ can be written as $J(b_1, b_2, \dots, b_n)$. Since this assumption ignores all features other than the desired reductions for individual indicators, we call it independence of irrelevant information.

Under this assumption, we state certain postulates for an arbitrary index J .

- *Normalization* (NM): For any $z, J(z, z, \dots, z)=z$.
- *Additivity* (AD): For any $b, r \in R^n, J(b_1+r_1, b_2+r_2, \dots, b_n+r_n)=J(b_1, b_2, \dots, b_n)+J(r_1, r_2, \dots, r_n)$.
- *Symmetry* (SM): $J(b)=J(bP)$ for any $b \in R^n$, where P is any $n \times n$ permutation matrix.⁵

According to NM, if the desired levels of deprivation reductions are the same for all indicators, then the global index takes on this common value. In particular, given b_j^0 values, if the desired level of deprivation is zero for all indicators; that is, if $b_j^T=0$ for all j , then $J=1$. Thus, the global index is an average of individual indices. Furthermore, when there is only one indicator the individual and global reductions sought are the same. AD can be interpreted as follows. Suppose indicator j has two components. For instance, if indicator j is income, then its two components can be wage and non-wage incomes. Then AD says that the sum of the reductions in deprivations demanded for wage and non-wage incomes is the same as the deprivation reductions demanded for total income from the two components. This property therefore shows how to calculate desired reductions when we split the indicators into components. Finally, SM requires insensitivity of J to arrangement of its arguments. That is, J remains invariant under any reordering of the individual I functions. Thus, anything other than individual desirable reductions in deprivations are irrelevant.

The following theorem, whose proof is similar to that of theorem 3 of Chakravarty and Majumder (2005), shows that NM, AD and SM identify G uniquely.

Theorem 2: J satisfies NM, AD and SM if and only if it is of the form

$$J(b_1, b_2, \dots, b_n) = \frac{1}{n} \sum_{j=1}^n I(b_j^0, b_j^T). \tag{8}$$

The index J in Equation (8) possesses the following properties:

- (i) *Increasingness*: It is increasing in its arguments; that is, as the extent of progress towards reducing the level of deprivations in one or more indicators increases, say, by reducing target year deprivations, the value of J increases.
- (ii) *Betweenness*: $\text{Min}\{I_1, \dots, I_n\} \leq J \leq \text{Max}\{I_1, \dots, I_n\}$; that is, J lies between minimal and maximal levels of deprivation reductions desired.
- (iii) *Quantitative assessment*: Since the global index J is the average of indicator-wise indices, we can make quantitative assessment of individual indicators. The quantity $C_i = b_i/nJ$ may be interpreted as the contribution of indicator i to the level of reduction in deprivation sought on a global basis, while $100 b_i/nJ$ is the percentage contribution of indicator i . Therefore, this kind of breakdown allows us to identify those indicators for which desired reductions are less/more. The high contributing indicators require more attention from policy point of view in order to increase the associated levels of desirable reductions. In such a case, the country may need to mobilize resources towards these indicators for reducing such deprivations and redefine its policy priorities.
- (iv) *Global period consistency*: We can have a global period consistency property that says that

$$J(b_1, \dots, b_n) = \frac{1}{n} \sum_{j=1}^n \left(\frac{b_j^{l-1} - b_j^T}{b_j^0} + \sum_{i=1}^{l-2} a_j^i \right). \quad (9)$$

Thus, given the achievements made over the subperiods $[t_0, t_1], [t_1, t_2], \dots, [t_{l-2}, t_{l-1}]$ for each indicator, this property tells us how much more we have to overcome to achieve the desired level of global reduction in deprivation. From policy point of view, the indicators for which the gaps $(b_j^l - b_j^T) / b_j^0$ are higher, need more attention on a priority basis.

Empirical illustration

The purpose of this section is to illustrate the indices I and J using data from several countries. Note that for the eight MDGs chosen by the United Nations, 18 targets have been set, mostly for 2015, using 1990 as benchmark. These 18 targets comprise 48 indicators. For instance, in Goal 4 there is only one target: reduce by two-thirds, between 1990 and 2015, the under-five mortality rate. The three corresponding indicators here are: under-five mortality rate, infant mortality rate, and proportion of one-year old children immunized against measles.

For our purpose the countries have been chosen to represent different parts of the world covering the continents Africa, Asia, Latin America and Europe. The other basis for choosing a country is the

availability of data for a maximum number of indicators. Thus, the 13 countries chosen by these criteria are Yemen (Arab State), Indonesia and the Philippines (East Asia and Pacific), Costa Rica, El Salvador, Venezuela (Latin America and Caribbean) Bangladesh, India, Pakistan, Sri Lanka (South Asia), Turkey (Southern Europe), and Senegal and Tanzania (sub-Saharan Africa). As mentioned earlier, in order to apply the period consistency property, and hence to monitor progress of a country towards achieving the targets, we have subdivided the interval [1990, 2015] into two subintervals [1990, 2000] and [2000, 2015]. The choice of indicators has therefore been guided by two principles: (i) availability of data for both 1990 and 2000, and (ii) unambiguous quantification of target values (for 2015). The 16 indicators that fulfilled the above criteria are:

- (1) Percentage of population earning below US\$1 per day (PPP values).
- (2) Poverty gap ratio.
- (3) Percentage of underweight children younger than five years of age.
- (4) Literacy rate of population between 15 and 24 years of age.
- (5) Ratio of girls to boys in primary, secondary and tertiary education.
- (6) Ratio of literate females to males in the age group 15–24 years.
- (7) Percentage of seats held by women in the national parliament.
- (8) Under-five mortality rate.
- (9) Infant mortality rate.
- (10) Percentage of one-year-old children immunized against measles.
- (11) Maternal mortality ratio.
- (12) Percentage of births attended by skilled personnel.
- (13) Prevalence of tuberculosis cases.
- (14) Carbon dioxide emissions per capita.
- (15) Percentage of population with access to improved water source.
- (16) Percentage of population with access to improved sanitation.

The first three columns of Table 1 present the Goals, targets and the names of the 16 indicators. The second row of columns 4–16 lists the selected countries. In columns 4–16 and rows 4–19 we present country-specific values of perceived growth indices $I(b_j^0, b_j^T)$, $j=1, 2, \dots, 16$. Finally, the last row shows the value of the index J , the average of I values across indicators, for each country.⁶ These values will be necessary for our analysis later in the section.

We mentioned at the outset that the analysis does not involve any inter-country comparisons of performances. This is because the key to sustainable human development is to maximize progress at the country level, not to compare country performances. Therefore, the assessment of the performances of the countries is confined to the country level.

Several interesting features emerge from Table 1. For the two countries in sub-Saharan Africa and one country in South Asia (Pakistan) we note negative values of the index for the health indicator ‘prevalence of tuberculosis cases’. That is, in 1990 each of these countries had achieved more than what has been desired by the targeted value of this indicator in

Table 1. Country-specific values of perceived growth indices for different indicators between the base period (1990) and the target period (2015)

		$I(b_j^0, b_j^t)$													
Goal	Target	Indicator	Yemen	Indonesia	Philippines	Costa Rica	El Salvador	Venezuela	Bangladesh	India	Pakistan	Sri Lanka	Turkey	Senegal	Tanzania
(Column 1)	(Column 2)	(Column 3)	(Column 4)	(Column 5)	(Column 6)	(Column 7)	(Column 8)	(Column 9)	(Column 10)	(Column 11)	(Column 12)	(Column 13)	(Column 14)	(Column 15)	(Column 16)
Goal 1	1	PP\$1	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
	1	PGAI	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
	2	UNW<5	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Goal 2	3	Y-ILI	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Goal 3	4	B/G	0.650	0.050	0.050	0.060	-0.020	0.010	0.190	0.290	0.520	0.070	0.110	0.280	0.020
	4	M/F	0.660	0.030	0.000	-0.010	0.030	-0.010	0.350	0.260	0.510	0.020	0.090	0.400	0.130
	4	MPA	0.479	0.432	0.451	0.438	0.432	0.444	0.444	0.474	0.444	0.474	0.495	0.425	0.451
Goal 4	5	MORT<5	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667
	5	INF MOR	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667	0.667
	5	NMEASL<1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Goal 5	6	MAT MOR	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
	6	UNATT	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Goal 6	8	TBCASE	0.420	0.072	0.410	0.441	0.419	0.221	0.304	0.181	-0.101	0.418	0.423	-0.190	-0.229
Goal 7	9	CO2EMS	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
	10	NO SAFE WATER	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
	11	NO SANIT MDG Index	0.646	0.545	0.565	0.566	0.562	0.550	0.589	0.584	0.594	0.570	0.578	0.566	0.532

Source: See Appendix A for explanation of the abbreviations of the indicators.

the respective country. In respect of the indicator 'ratio of literate males to females in the age group of 15–24 years', Costa Rica, Venezuela and the Philippines achieved exactly the targeted figure for this indicator in 1990. Finally, in the case of El Salvador, achievement in respect of the indicator 'ratio of girls to boys in primary, secondary and tertiary education' during the base period was better. In all other cases we find that the 1990 figures are higher than the desired figures (in 2015), which is why the index values are positive for all such cases. We note that in Venezuela the value 0.01 has been observed for the indicator 'ratio of girls to boys in primary, secondary and tertiary education'. For four indicators ('youth illiteracy rate', 'non-immunization against measles', 'births not attended by skilled personnel' and 'percentage of population with access to improved sanitation') the value one has been found in Venezuela as well as in all other countries. Thus, in the latter four cases it is desired that all countries will reduce the base period deprivation figures to zero. In fact, we note that among positive values of I , for 12 indicators the common value of the index ranges from 0.05 to one. Thus, for these indicators the same extent of progress, however small or large it may be, is desired for all countries for achieving the respective targets. We can analyze the other figures in Table 1 in an analogous way.

Next, it will be worthwhile to examine the performances of the countries in the period [1990, 2000] towards reaching the Goals. Because of this we calculate the country-wise values of the achievement index $(b_j^0 - b_j^1) / b_j^0$ for different indicators, where the superscript '1' in b_j^1 indicates the year 2000. These values are presented in Table 2, the format of which is similar to that of Table 1. A positive value of the index for any indicator demonstrates that the country has made some progress towards achieving the targeted value, whereas a negative value means that the country's position, in the context of the indicator, has worsened in comparison with 1990. We note from Table 2 that each country has done poorly with respect to at least one indicator. For India, poor performance is noted only in one case (carbon dioxide emission). In fact, for carbon dioxide emission, the two sub-Saharan countries have been able to maintain their respective positions and Venezuela made some progress. But for all other countries the situation is rather discouraging relative to their economic development.

We then note that for Costa Rica and El Salvador, sharp downturns are found for a maximum number of indicators — namely, in six cases — while the position of Yemen and Tanzania has worsened in five cases. For the remaining countries, this dismal picture is observed for the number of indicators ranging from two to four. Some countries advanced in some dimensions, but the progress has been uneven. For instance, Indonesia, Pakistan and the two sub-Saharan countries individually have performed well in reducing poverty, but their progress has in some cases been slower; for example, in achieving gender parity in primary, secondary and tertiary education. Although India is on the right track in all dimensions, except

Table 2. Country-specific values of growth indices for different indicators between the base period (1990) and 2000

Goal	Target	Indicator	Yemen	Indonesia	Philippines	Costa Rica	El Salvador	Venezuela	Bangladesh	India	Pakistan	Sri Lanka	Turkey	Senegal	Tanzania
(Column 1)	(Column 2)	(Column 3)	(Column 4)	(Column 5)	(Column 6)	(Column 7)	(Column 8)	(Column 9)	(Column 10)	(Column 11)	(Column 12)	(Column 13)	(Column 14)	(Column 15)	(Column 16)
$I(b_j^0, b_j^1)$															
Goal 1	1	PP\$1	-2.925	0.576	0.270	-0.380	0.144	-4.000	0.000	0.174	0.721	-0.650	0.050	0.416	0.594
	1	PGAP	-3.091	0.630	0.357	-1.615	0.218	-10.50	0.080	0.248	0.836	-0.429	0.183	0.653	0.803
	2	UNW<5	-0.179	0.257	0.067	-1.500	-0.091	0.167	0.284	0.113	0.000	0.237	0.200	0.100	0.000
Goal 2	3	Y-ILL	0.330	0.580	0.556	0.346	0.290	0.525	0.122	0.252	0.198	0.367	0.548	0.195	0.473
Goal 3	4	B/G	0.417	0.000	0.010	-0.011	-0.097	-0.053	0.156	0.078	0.127	0.011	0.000	0.172	0.020
	4	M/F DALLIT	0.414	0.020	0.000	0.000	0.010	0.000	0.085	0.098	0.183	0.020	0.042	0.155	0.084
	4	MPAR	-0.031	-0.045	0.099	0.270	-0.023	0.000	-0.089	0.042	0.133	-0.011	0.030	0.069	0.143
Goal 4	5	MORT<5	0.246	0.505	0.424	0.353	0.350	0.185	0.465	0.244	0.148	0.174	0.419	0.068	-0.012
	5	INF MOR	0.194	0.450	0.356	0.400	0.283	0.174	0.469	0.163	0.125	0.105	0.410	0.122	-0.020
	5	NMEASL<1	0.323	0.024	-0.667	-0.800	-0.500	-0.308	0.314	0.000	0.080	0.950	0.545	-0.061	0.150
Goal 5	6	MAT MOR	0.393	0.277	0.143	0.417	0.400	0.642	0.294	0.228	0.412	0.571	0.694	0.000	-0.429
	6	UNATT	0.071	0.313	0.064	0.714	-2.769	0.839	-0.023	0.136	0.012	0.500	0.208	0.093	-0.362
Goal 6	8	TBCASE	0.420	0.072	0.410	0.441	0.419	0.221	0.304	0.181	-0.101	0.418	0.423	-0.190	-0.229
Goal 7	9	CO2EMS	-0.571	-0.333	-0.429	-0.600	-0.800	0.086	-1.000	-0.375	-0.167	-1.500	-0.192	0.000	0.000
	10	NO SAFE WATER	0.205	0.368	0.071	0.500	0.161	0.238	0.000	0.368	0.538	0.605	0.150	0.542	0.258
	11	NO SANIT Index J	0.276	0.306	0.261	0.750	0.105	0.366	0.096	0.028	0.264	0.541	-2.000	0.286	0.286
			-0.219	0.250	0.125	-0.045	-0.119	-0.714	0.097	0.124	0.219	0.119	0.107	0.164	0.110

one, its progress is rather slow. A comparison across indicators shows that Sri Lanka has made maximum progress for the indicator 'immunization against measles'. Turkey, the only European country we have considered, also does well in this dimension. But although Turkey did well in two more dimensions (reducing the maternal mortality ratio and illiteracy rate among 15–24 year olds), its performance has been bleak for the dimension 'sanitation improvement'.

Table 3 indicates the levels of achievements a country has to make during the period 2000–2015 in different dimensions, so as to reach the respective targeted values. In view of period consistency, the i th column of Table 3 is obtained by subtracting column i of Table 2 from column i of Table 1, where $i=4, 5, \dots, 16$. We present Table 3 separately for the purpose of policy discussion. Naturally, because some countries have already achieved the Goals in 2000 or did even better in some dimensions, the index values in such cases are zero or negative. For instance, Indonesia, Pakistan, Senegal and Tanzania performed better than what has been aimed for in the respective country in reducing poverty gap ratio. As expected, because of Venezuela's poor performance during 1990–2000, the country has to put considerable effort in order to achieve the targets by 2015. Yemen, El Salvador and Costa Rica also need to reduce deprivation sufficiently to reach the respective targets (see last row in Table 3). Indonesia and Pakistan are in comfortable positions, while the situation for the remaining countries is moderate.

Given the necessity of global progress over the period 2000–2015 towards reaching the Goals, it becomes essential to identify the areas requiring most attention. Accordingly, in Table 4, we present for each country the percentage contributions of different indicators to the level of progress desired globally. These contributions are calculated from figures in Table 3. Reaching the targeted value of an indicator will necessitate lowering the globally desirable reduction by the percentage by which it contributes to the total value.

Before we analyze the figures in Table 4 it should be noted that a negative percentage contribution of an indicator due to its over-performance will proportionately raise shares of indicators that are contributing positively, so that the total adds up to 100. We can certainly recalculate the contributions of the indicators by dropping the ones with negative contributions. But relative positions of the indicators in terms of contributions are the same in the two cases. Furthermore, reporting of the negative contributions enables us to easily compare relative performances. More importantly, resting on the laurels of past gains may lead to complacency, which may result in erosion of progress over time. In view of this, we present the negative figures with the expectation that the country will continue this level of achievement or do even better. Another important point is that overall progress will be hindered by inaction on any one of the indicators, however small its contribution may be.

Table 3. Country-specific values of perceived growth indices for different indicators between 2000 and the target period (2015)

Goal (Column 1)	Target (Column 2)	Indicator (Column 3)	$I(b_j^1, b_j^T)$													
			Yemen (Column 4)	Indonesia (Column 5)	Philippines (Column 6)	Costa Rica (Column 7)	El Salvador (Column 8)	Venezuela (Column 9)	Bangladesh (Column 10)	India (Column 11)	Pakistan (Column 12)	Sri Lanka (Column 13)	Turkey (Column 14)	Senegal (Column 15)	Tanzania (Column 16)	
Goal 1	1	PP\$1	3.425	-0.076	0.230	0.880	0.356	4.500	0.500	0.326	-0.221	1.150	0.450	0.084	-0.094	
	1	PGAP	3.591	-0.130	0.143	2.115	0.282	11.000	0.420	0.252	-0.336	0.929	0.317	-0.153	-0.303	
	2	UNW<5	0.679	0.243	0.433	2.000	0.591	0.333	0.216	0.387	0.500	0.263	0.300	0.400	0.500	
Goal 2	3	Y-ILL	0.670	0.420	0.444	0.654	0.710	0.475	0.878	0.748	0.802	0.633	0.452	0.805	0.527	
Goal 3	4	B/G	0.233	0.050	0.040	0.071	0.077	0.063	0.034	0.212	0.393	0.059	0.110	0.108	0.000	
	4	M/F LIT	0.246	0.010	0.000	-0.010	0.020	-0.010	0.265	0.162	0.327	0.000	0.048	0.245	0.046	
Goal 4	4	MPAL	0.510	0.477	0.352	0.169	0.455	0.444	0.533	0.432	0.311	0.484	0.465	0.356	0.308	
	5	MORT<5	0.420	0.161	0.242	0.314	0.317	0.481	0.201	0.423	0.518	0.493	0.248	0.599	0.679	
	5	INFMOR	0.473	0.217	0.311	0.267	0.384	0.493	0.198	0.504	0.542	0.561	0.257	0.544	0.686	
Goal 5	5	NMEASL<1	0.677	0.976	1.667	1.800	1.500	1.308	0.686	1.000	0.920	0.050	0.455	1.061	0.850	
	6	MATMOR	0.357	0.473	0.607	0.333	0.350	0.108	0.456	0.522	0.338	0.179	0.056	0.750	1.179	
Goal 6	6	UNATT	0.929	0.688	0.936	0.286	3.769	0.161	1.023	0.864	0.988	0.500	0.792	0.907	1.362	
	8	TBCASE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Goal 7	9	CO2EMS	0.621	0.383	0.479	0.650	0.850	-0.036	1.050	0.425	0.217	1.550	0.242	0.050	0.050	
	10	NO SAFE WATER	0.295	0.132	0.429	0.000	0.339	0.262	0.500	0.132	-0.038	-0.105	0.350	-0.042	0.242	
	11	NO SANIT Index J	0.724	0.694	0.739	0.250	0.895	0.634	0.904	0.972	0.736	0.459	3.000	0.714	0.714	
			0.866	0.295	0.441	0.611	0.681	1.264	0.492	0.460	0.375	0.450	0.471	0.402	0.422	

Table 4. Percentage contributions of different indicators to the progress desired globally in 2015 (from the level achieved in 2000)

Goal	Target	Indicator	Yemen	Indonesia	Philippines	Costa Rica	El Salvador	Venezuela	Bangladesh	India	Pakistan	Sri Lanka	Turkey	Senegal	Tanzania
(Column 1)	(Column 2)	(Column 3)	(Column 4)	(Column 5)	(Column 6)	(Column 7)	(Column 8)	(Column 9)	(Column 10)	(Column 11)	(Column 12)	(Column 13)	(Column 14)	(Column 15)	(Column 16)
Goal 1	1	PPS1	24.73	-1.62	3.26	9.00	3.27	22.26	6.36	4.43	-3.68	15.96	5.97	1.31	-1.39
	1	PGAI	25.92	-2.75	2.03	21.63	2.59	54.41	5.35	3.43	-5.60	12.89	4.20	-2.39	-4.50
Goal 2	2	UNW	4.91	5.15	6.15	20.45	5.42	1.65	2.75	5.26	8.34	3.65	3.98	6.22	7.41
	3	Y-ILLI	4.84	8.90	6.30	6.69	6.52	2.35	11.16	10.16	13.38	8.78	6.00	12.52	7.81
Goal 3	4	B/G	1.68	1.06	0.56	0.72	0.70	0.31	0.43	2.88	6.55	0.82	1.46	1.67	0.00
	4	M/F	1.78	0.21	0.00	-0.10	0.18	-0.05	3.38	2.21	5.45	0.00	0.64	3.81	0.68
Goal 4	4	MPA	3.68	10.12	4.99	1.72	4.17	2.20	6.78	5.86	5.19	6.72	6.16	5.54	4.56
	5	MOR	3.03	3.42	3.44	3.21	2.91	2.38	2.56	5.74	8.64	6.84	3.29	9.32	10.07
	5	INF	3.41	4.59	4.41	2.73	3.53	2.44	2.52	6.85	9.03	7.79	3.41	8.47	10.18
Goal 5	5	NMEAS	4.89	20.69	23.64	18.41	13.77	6.47	8.72	13.59	15.34	0.69	6.03	16.51	12.60
	6	MAT	2.58	10.03	8.61	3.41	3.21	0.54	5.80	7.09	5.64	2.48	0.74	11.67	17.47
Goal 6	6	UNATT	6.70	14.57	13.28	2.92	34.60	0.80	13.01	11.73	16.47	6.94	10.50	14.11	20.19
	8	TBCASE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goal 7	9	CO2EMS	4.49	8.13	6.79	6.65	7.80	-0.18	13.35	5.77	3.61	21.51	3.21	0.78	0.74
	10	NO SAFE WATER	2.13	2.79	6.08	0.00	3.11	1.30	6.36	1.79	-0.64	-1.45	4.64	-0.65	3.59
Goal 7	11	NO SANIT	5.22	14.71	10.48	2.56	8.21	3.14	11.49	13.20	12.27	6.38	39.79	11.11	10.59
		Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

For Yemen, the only Arab State we have considered, the maximum challenge remains in key areas of poverty. Although it has made notable progress in several areas, such as gender parity in education and combating major diseases, reasonable progress will be needed in some areas including sanitation improvement, maternal and child health care, hunger and carbon dioxide emission.

Of the two countries in East Asia and the Pacific, Indonesia has performed quite well in reducing poverty. But, as is also the case for the Philippines, significant achievements are required in respect of healthcare for women during childbirth, child healthcare, carbon dioxide emission and sanitation improvement. Major attention should also be given to the issues of youth illiteracy and hunger. Moreover, in Indonesia women empowerment remains a serious problem.

Among the three Latin American and Caribbean countries, the trend towards poverty has been highly negative for Venezuela. Its position in respect of the pertinent indicators worsened by 2000 relative to 1990, indicating that the country needs to revise its policy options for achieving the respective targets. Although the two other countries in this region did better in these dimensions, for Costa Rica poverty and hunger remain important areas of explicit concern, and child healthcare in terms of immunization against measles is also an issue of major concern. Similarly, in the case of El Salvador, child healthcare is a problem, although the situation is relatively worse in respect of maternal healthcare. Clear focus for improving performance in this latter dimension is required. Among the countries in South Asia, Pakistan has been quite successful in reducing both dimensions of poverty observed in 1990. In Sri Lanka, poverty and carbon dioxide emission remain major areas of attention. The challenge of the years to come will be to discover forms of intervention that can eradicate poverty and improve environmental quality. Bangladesh also needs to pay serious attention to the environmental issue. In Bangladesh, India and Pakistan, challenges remain in key areas such as youth illiteracy, child and maternal healthcare and sanitation.

For Turkey a high level of improvement in sanitation is needed for the MDG target to be met. The next issue of major concern is maternal healthcare. Positions in youth literacy, women empowerment and child healthcare are also vulnerable.

The two sub-Saharan African countries are diverse performers. They achieved progress in poverty reduction. But the two countries face challenges in several areas such as hunger, child healthcare in terms of immunization, sanitation, youth literacy, maternal healthcare and infant and maternal mortality. This points to the need of greater focus on improved health, education and related areas, and these countries may need to reformulate respective policies for achieving the Goals in these areas. However, good governance, although vital for success, may not be enough. External finance and better cooperation in international system will probably be necessary to make the targets attainable in these countries.

Conclusions

The MDGs involving concrete targets and indicators present a new approach to help countries escape poverty and achieve desired objectives in several dimensions of human well-being. The MDGs follow a performance rather than an entitlement approach to development. This paper suggests an index of perceived progress for each indicator, which can be employed to monitor the achievement made towards attaining the Goals. A composite index of desired progress involving different indicators is also presented. This index is helpful in determining the percentage contributions made by different indicators to the extent of overall targeted progress. The high contributing indicators may require the attention of policy-makers to improve their positions so that attainability of the corresponding targets can be ensured to a greater extent. An empirical illustration of the indices using cross-country data for several indicators serves as a basis for discussion.

To illustrate one implication of the proposed index, suppose that, in terms of percentage reduction in deprivation of an indicator, the first half of the targeted years made a progress of 50%, so that in the second half also a 50% progress is required. Then, according to our index, the country would be viewed as making the same progress in both the periods specified. But it may often be the case that the achievement of 50% progress in the first half is easier or harder than that in the second half. This is quite relevant from a policy perspective and we leave this issue for a future research program.

Our discussion on policy issues has been country specific. However, often it may be worthwhile to put priorities on worst-performing indicators globally. This would require the construction of an index, under appropriate assumptions, for the given indicator for all the countries or for a subset of countries (e.g. in the South Asian region). In such a case, country-wise percentage reductions in the deprivation of the indicator can be calculated for policy purpose, another important issue for future research.

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Notes

- 1 Several contributions have stressed the need for viewing human well-being as a multidimensional phenomenon. See, for example, Kolm (1977), Streeten (1981), Atkinson and Bourguignon (1982), Sen (1985, 1987, 1997), UNDP (1990–2006), Tsui (1995, 1999, 2002), Ravallion (1996), Chakravarty et al. (1998), Bourguignon and Chakravarty (1999, 2003), Atkinson (2003), Chakravarty (2003, 2006), Chakravarty and Majumder (2005), Weymark (2006), and Chakravarty and Silber (2007).

- 2 This procedure, which Dutta *et al.* (2003) referred to as procedure II, was adopted in Chakravarty (2003) and Chakravarty and Majumder (2005) for developing generalizations of the Human Development and Human Poverty Indices.
- 3 The term 'global' relates to the *norms*, as indicated in column two of the table in Appendix A. The targets are, however, country specific.
- 4 For specification of these indicators and for the targets and Goals corresponding to all the indicators used, see Appendix A.
- 5 An $n \times n$ permutation matrix is a square matrix of order n where each row and each column has exactly one entry having the value '1' and the rest of the entries have the value '0'.
- 6 Since the numbers of indicators belonging to the different Goals are not the same, this simple averaging assigns different weights (determined by data) to indicators across MDGs in the aggregation.

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Appendix A. Goals, Targets, List of Indicators used and their Definitions^a

Goal	Target	Name of indicator	Type of indicator	Definition of indicator
1: Eradicate extreme poverty and hunger	1: Halve, between 1990 and 2015, the proportion of people whose income is less than \$1 a day	PP\$1%	Original	Percentage of population earning below \$1 a day (PPP values)
		PGAP	Original	Poverty gap ratio
	2: Halve, between 1990 and 2015, the proportion of people who suffer from hunger	UNWT<5	Original	Prevalence of underweight children under five years of age (%)
2: Achieve universal primary education	3: Ensure that, by 2015, child everywhere, boys and girls alike, will be able to complete a full course of primary schooling	Y-ILLIT	Transformed	Youth (age 15–24) illiteracy rate (%) = 100 – Youth literacy rate
3: Promote gender equality and empower women	4: Eliminate gender disparity in primary and secondary education preferably by 2005 and to all levels of education no later than 2015	B/G	Transformed	Ratio of boys to girls in primary, secondary and tertiary education = 1/(Ratio of girls to boys in primary, secondary and tertiary education)
		M/F Y-ILLIT	Transformed	Ratio of literate males to females (age 15–24 years) = 1/Ratio of literate females to males (age 15–24 years)
		MPAR	Transformed	Seats in Parliament held by men (as % of total) = 100 – Seats in Parliament held by women (as % of total)
4: Reduce child mortality	5: Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate	MORT<5	Original	Under five mortality rate (per 1000 live births)
		INF MOR	Original	Infant mortality rate (per 1000 live births)
		NMEASL<1	Transformed	One-year-olds not fully immunized against measles (%) = 100 – One-year-olds fully immunized against measles (%)

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Appendix A. Continued.

Goal	Target	Name of indicator	Type of indicator	Definition of indicator	
5: Improve maternal health	6: Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio	MATMOR	Original	Maternal mortality ratio (per 100 000 live births)	
		UNATT	Transformed	Births not attended by skilled personnel (%) = 100 – Births attended by skilled personnel (%)	
6: Combat major diseases	8: Have halted by 2015, and begun to reverse the incidence of malaria and other major diseases	TBCASE	Original	Prevalence of tuberculosis cases (per 100 000 people)	
7: Ensure environmental sustainability	9: Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources	CO2EMS	Original	Carbon dioxide emissions per capita (metric tons)	
		10: Halve, by 2015, the proportion of people without sustainable access to safe drinking water	NO SAFE WATER	Transformed	Population without access to improved water source (%) = 100 – Population with access to improved water source (%)
		11: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers	NO SANIT	Transformed	Population without access to improved sanitation (%) = 100 – Population with access to improved sanitation (%)

^aThe Goals and Targets have been set by the United Nations and are available in the *Human Development Reports*. There are several other Goals and Targets listed in the *Human Development Reports*. Here we have listed only those that correspond to the indicators chosen. As already mentioned, the choice of indicators has been guided by two principles: (i) availability of data for both 1990 and 2000, and (ii) unambiguous quantification of target values (for 2015).