IS THE HUMAN DEVELOPMENT INDEX REDUNDANT?

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INTRODUCTION

Since its inception in the 1990 *Human Development Report* (*HDR*), the Human Development Index (HDI) has been controversial. It was set up to replace Gross Domestic Product (GDP) as the main gauge of development. As the 1993 *HDR* quote of Anand and Sen [1992] summarizes, "Income, commodities ("basic" or otherwise), and wealth do of course have instrumental importance but they do not constitute a direct measure of the living standard itself" [UNDP 1993, 106].[1] Some researchers have suggested, however, that since other development index statistics are so closely correlated with GDP or GNP per capita, they are redundant in forming an index.[2]

But how much correlation renders a statistic redundant? McGillivray [1991] suggests that a correlation coefficient of greater than zero for any component statistic and the HDI is sufficient to dismiss the HDI of presenting new information. This article further suggests that the degree of redundancy can be measured by how close the correlation coefficient is to one. Finally, McGillivray [1991] suggests that the very high rank-order correlation between the HDI and GNP per capita indicates that the HDI does not present any new information above what can be learned from per capita GNP. McGillivray and White [1993] propose alternative criteria for redundancy. First, a variable is considered to be redundant if the correlation coefficient is above 0.90 ("Level 1 redundancy") or 0.70 ("Level 2 redundancy") [McGillivray and White 1993, 187]. Second, a variable is considered redundant if a "restricted" HDI computed with the component excluded is highly correlated with the excluded component [McGillivray and White 1993, 188].

This article updates these earlier studies to show that the individual indexes used as component statistics in the current HDI are indeed highly correlated, using methods similar to those developed by McGillivray [1991] and McGillivray and White [1993].[3] The analysis is then extended by presenting a unique illustration of the impact of this correlation: alternative weighting schemes are found that form two sets of indexes that are 1) statistically indistinguishable; and 2) very highly correlated with the original HDI. These weights vary widely from the original HDI weights. For example, it is shown that it is possible to exclude any one of the HDI components and still achieve a correlation of 0.95 (or higher) to the original HDI.

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THE HDI

In its current formulation (last revised in 1999), the HDI is a composite index of four statistics: life expectancy at birth, the adult literacy rate, a combined school enrollment ratio, and GDP per capita in purchasing power parity terms. The HDI does not, however, employ raw statistics in its index, partly because it is not possible logically to combine statistics with unlike units of measure. Instead, the HDI methodology creates intermediate component statistics that rate each country's relative performance in each category. Specifically, each country is rated on a scale from zero to one, in which zero and one are theoretical lower and upper limits of society's capability (see UNDP [2001] for details). The enrollment and literacy statistics are then combined to form an education index, in which literacy is given a weight of two-thirds and enrollment one-third. GDP is also transformed by taking the natural logarithm to give it diminishing returns. The three component indexes are then averaged together, each with an equal weight of one-third.

CORRELATION BETWEEN COMPONENT STATISTICS

Table 1 displays the Pearson (zero-order) and Spearman (rank-order) correlation matrices for the three component indexes for the 2001 HDI. The correlation coefficients are indeed large, and each of the correlation coefficients is significantly greater than zero. Each of the coefficients is significantly less than one, however, implying that some information is unique to each series. Nevertheless, the McGillivray [1991] and McGillivray and White [1993] standards would reject the HDI as being redundant, and to a high degree.

TABLE 1
Correlation Coefficients for Adjusted HDI Component Statistics

Pearson zero-order correlation

	educ. index	**GDP index**	**HDI**
life exp. index.	0.791*	0.816*	0.936**
educ. index.		0.774*	0.922**
GDP index			0.928**

Spearman rank-order correlation

	educ. index	**GDP index**	**HDI**
life exp. index	0.796*	0.857*	0.945**
educ. index		0.791*	0.905**
GDP index			0.942**

*significantly different from 0 and 1 at the 99.9 percent level of significance.
**significantly different from 0 at the 99.9 percent level of significance, significantly different from 1 at the 98 percent level of significance.

Interestingly, the adjusted statistics are indeed more highly correlated (in terms of zero-order correlation) with each other than the unadjusted statistics, as Table 2 shows.[4] That is, some diversity of information may be lost in the adjustment calculation.

TABLE 2
Correlation Coefficients for Raw HDI Component Statistics

Pearson (zero-order) correlation

	Adult lit. rate	school enroll. ratio	GDP per capita	HDI
Life exp. at birth	0.757*	0.758*	0.673*	0.936**
Adult lit. rate		0.812*	0.553*	0.883*
school enroll. ratio			0.663*	0.885*
GDP per capita				0.777*

Spearman (rank-order) correlation

	Adult lit. rate	school enroll. ratio	GDP per capita	HDI
Life exp. at birth	0.753*	0.729*	0.860*	0.945**
Adult lit. rate		0.796*	0.732*	0.860*
school enroll. ratio			0.788*	0.843*
GDP per capita				0.943**

*significantly different from 0 and 1 at the 99.9 percent level of significance.
** significantly different from 0 at the 99.9 percent level of significance, significantly different from 1 at the 97 percent level of significance.

INDEX WEIGHT RESULTS

It has been established that the component statistics of the HDI are highly, but not perfectly, correlated with each other. But what is the implication for this high degree of correlation for the HDI results? One way to consider this is to find alternative weighting schemes that produce indexes that are highly correlated with the original HDI. Specifically, the goal is to find the extremes for weights that produce an index very much like the HDI. Table 3 presents six sets of alternative weights that produce an index that has a Pearson correlation coefficient with the original HDI of 0.99. A correlation coefficient of 0.99 is significantly different from zero at the 99.9 percent confidence level; however, we can not reject the hypothesis that the correlation is equal to one at the 85 percent confidence level.[5] Table 4 presents weights for an index that has a correlation coefficient with the original HDI of 0.95. A correlation coefficient of 0.95 is significantly different from zero at the 99.9 percent confidence level and significantly different from one at the 97 percent level. The Spearman rank-order correlation coefficients are also reported on Tables 3 and 4, and are not significantly different from the Pearson correlation coefficients.

Table 3 shows that an index may be statistically indistinguishable from the HDI and still have a wide variety of weights, as low as 9 percent for a statistic in two examples, and as high as 59 percent in another example. Table 4 shows that when the criterion is lowered somewhat so that the alternative index is not indistinguishable from, but very closely correlated with, the HDI, it is possible to compute an index in which any of the statistics is eliminated and one of the statistics is given a weight of at least 85 percent. Most dramatically, when GDP is eliminated, an index with a weight of 92 percent on life expectancy and 8 percent on education has a 0.95 correlation with the original HDI.

TABLE 3
Alternative Index Weights for Index with 0.99 Correlation with HDI

Goal	HDI index weights life exp.	education	GDP	Rank-order correlation
high life exp. weight	**0.585**	0.228	0.187	0.991*
low life exp. weight	**0.085**	0.439	0.476	0.990*
high educ. weight	0.216	**0.556**	0.228	0.986*
low educ. weight	0.454	**0.111**	0.435	0.989*
high GDP weight	0.187	0.238	**0.575**	0.990*
low GDP weight	0.483	0.429	**0.088**	0.984*

*not significantly different from 0.99 at 75 percent level of significance.

TABLE 4
Alternative Index Weights for Index with 0.95 Correlation with HDI

Goal	HDI index weights life exp.	education	GDP	Rank-order correlation
high life exp. weight	**0.153**	0.847	0.000	0.931*
high life exp. weight	**0.137**	0.000	0.863	0.957*
low life exp. weight	**0.000**	0.850	0.150	0.939*
low life exp. weight	**0.000**	0.115	0.885	0.953*
high educ. weight	0.064	**0.854**	0.082	0.936*
low educ. weight	0.903	**0.000**	0.097	0.953*
low GDP weight	0.917	0.083	**0.000**	0.952*

*not significantly different from 0.95 at 80 percent level of significance.

CONCLUSION

The statistics used in the HDI are so closely correlated with one another that indistinguishable alternative indexes can be created from the same statistics with very different weights. In fact, an index that consists of a 58 percent weight on adjusted GDP, 24 percent on the education index and 19 percent on the life expectancy index is statistically indistinguishable from the HDI. An index that consists of an 89 percent weight on adjusted GDP and the remaining weight on the education index has a 0.95 correlation with the HDI. Therefore, this paper not only updated the McGillivray [1991] and McGillivray and White [1993] studies of the earlier HDI, but expanded the analysis to show the implications.

There are two ways of interpreting these results. A view supportive of the HDI is that it is robust to a wide variety of index weights. That is, the debate over the relative weighting scheme is largely irrelevant. The conclusions of the HDI therefore cannot be dismissed on the basis that the relative weights bias the results towards favoring a particular aspect of development.[6] This is important because several studies have suggested that the HDI weighting scheme is subjective, or even random (see, for example, Noorbakhsh [1998], Ravallion [1997], and Desai [1991]).

The view critical of the HDI is that it appears that a second or third statistic adds only a relatively small amount of information about development to any one statistic. To focus on GDP, an index very close to the HDI can be constructed with either an 89

percent weight on per capita GDP, or a 0 percent weight on per capita GDP; both results suggest that most information about the HDI is captured in per capita GDP. Based on an analysis with similar results, McGillivray [1991, 1467] concluded, "…the UNDP's index is yet another redundant composite intercountry development indicator."

NOTES

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1. Qizilbash [1996] surveys a large number of variables and concepts to consider when measuring development in the context of critiquing Sen's work. This paper suggests that composite indexes like the HDI are useful, but is concerned that the components of the HDI do not perfectly match the theory laid out in the paper and are not broad enough. Alkire [2002] provides a more recent and more extensive list of development indicators.
2. McGillivray [1991] was among the first to do so, and concluded that it would be helpful to develop new indicators to assess development. Larson and Wolford [1979] and Hicks and Streeten [1979] performed similar analyses of earlier indexes.
3. These articles study the first (1990) version of the HDI; the current (1999 method version) HDI uses different data and construction methods.
4. Cahill [2002] shows that the natural logarithm of GDP is more highly correlated with the other statistics.
5. The p-value is 0.186 for the one-tailed t-test.
6. This is similar to a conclusion made by McGillivray and White [1993] on the topic of measurement error. The article noted that even when assuming a 10 or 15 percent error applied to each of the HDI index statistics, the assumed true HDI and reported HDI had a very high rank-order correlation.

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