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Engendering Human Development:
A Critique of the UNDP's Gender-Related Development Index

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Abstract: This article reviews the literature critiquing the UNDP's Gender-related Development Index (GDI), which is a measure of human development penalized for the extent of gender inequality in each country; presents several original critiques of GDI; and presents proposed corrections to the GDI in response to both received and original critiques.

Keywords: Gender-related Development Index; GDI; human development; gender disparities

JEL codes: I32, J16, O15

The Gender-related Development Index (GDI), published annually since 1995 in the United Nations Development Program's (UNDP's) *Human Development Report* (*HDR*), is designed to highlight gender disparities in human development. A variation on the Human Development Index (HDI), GDI is a composite index used to rank human well-being among 140 countries. Measures of life expectancy, adult literacy, school enrollment, and income per capita are first assigned a penalty based on the extent of gender inequality present in a given nation and then combined in a formula identical to that of HDI.[1] The difference between HDI and GDI can be interpreted as a gender-inequality penalty. GDI, then, is not a measure of women's development, nor of gender inequality, but rather a measure of human development that includes health, education, and income, plus the degree to which the well-being of a society as a whole suffers as a result of any gender disparity in access to these three proxies for human capabilities.

This chapter questions whether or not GDI, as currently constructed, achieves the best possible measure of gender-inequality-sensitive human development. I begin with an examination of the quality of the data used to calculate GDI and the appropriateness of the components chosen to assess gender inequality. Without a strong foundation of high-quality data well-suited to drawing attention to disparities between women and men, all the calculations that follow are irrelevant. Key questions include: How good are the data that are used in computing GDI? Is GDI based on the data most appropriate to measuring gender inequality?

Special attention is given to the estimation of women's and men's incomes used in GDI. Unlike for life expectancy, literacy, and school enrollment, gender-specific income data do not exist for most countries. The techniques used to first estimate gendered incomes and then discount them to reflect diminishing marginal utility have important effects on GDI values. How best can gendered incomes be estimated in the absence of data, or is there a better way to measure women's material well-being? How best can gendered incomes be adjusted for diminishing returns to each new unit of income?

In constructing GDI, indices for health, education, and income are generated, and then these three indices are combined in a simple, unweighted average. While on the surface this implies a balance of importance among the gender-inequality penalties for the three components, implicit weights may exist if the range of the component penalties is imbalanced. Does each of the components have the same average impact on the final GDI value?

The health, education, and income indices are assigned penalties for the extent of gender inequalities in a formula that includes female and male population shares, the gender-specific component indices, and a parameter representing society's aversion to gender inequality. The value assigned to gender inequality's impact on overall human development, the treatment of

[1] HDI is the mean of component indices for health (based on average life expectancy), education (based on literacy and school enrollment rates), and income (based on purchasing-power-parity (PPP) adjusted Gross Domestic Product (GDP) per capita.

cases where female indices exceed males, and the effect of particularly uneven female and male population shares each can have unexpected, and unintended, consequences for GDI. How strong is society's aversion to gender inequality, and is this reflected in GDI? Should female advantages in capabilities be treated the same as male advantages when measuring gender inequality? What effect does a disproportionately small female population have on GDI values?

After the data are chosen, gendered income is estimated, penalties are assigned, and components are averaged together, the resulting GDI is expected to differ from HDI. That difference represents the loss of well-being due to gender inequality in each country. How large are the differences between HDI and GDI, and do they accurately portray levels of gender inequality?

Finally, in order for GDI to be useful not just to economists but to policy-makers, development professionals, and a broader public, GDI must not only be distinguishable from HDI. It also must be clear and relatively simple. Is the GDI accessible to policy-makers and development practitioners world-wide? Or does it require a specialist to calculate it, or even to interpret it? Before embarking on an examination of these concerns in greater detail, the next section of this chapter will explain the construction of the GDI.

Understanding the GDI[2]

GDI is a social welfare function that includes health, education, income, and the degree to which a country's aggregate wel-being suffers as a result of gender disparities in the availability of these three capabilities. More specifically, the GDI is a variation on the HDI in which each component – life expectancy, adult literacy, school enrollment, and income – is penalized for its extent of gender inequality before the four components are combined into a single index. GDI is not a measure of women's development, nor is it a measure of gender inequality. Instead it is a measure of overall human development that takes into consideration gender disparities' negative impacts on the average well-being of an entire society.

Each of the four components of GDI uses the same basic formula to penalize gender disparities. First, female and male-specific indices are calculated using the same normalization method as in HDI:

$$(1)\ \text{Female-Index}_i = \frac{\text{Female Actual Value}_i - \text{Female Minimum Value}}{\text{Female Maximum Value} - \text{Female Minimum Value}}$$

$$(2)\ \text{Male-Index}_i = \frac{\text{Male Actual Value}_i - \text{Male Minimum Value}}{\text{Male Maximum Value} - \text{Male Minimum Value}}$$

where the subscript i indicates the country.

[2] The GDI values used throughout this chapter are based on the author's replication, made necessary because GDI's component indices and penalties are not reported in the *HDR*s. For 2003 data by gender for all 140 countries, as reported in *HDR 2005*, see Appendix A. For a discussion of the method of replication used in this study and values of component Equally Distributed Indices see Appendix B.

Then the female and male indices for each component, along with the female and male population shares (FemalePopShare and MalePopShare) are combined to form an "Equally Distributed Index" (ED Index) using the following formula:

$$(3)\ \text{ED-Index}_i = [(\text{FemalePopShare}_i * \text{Female-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

The parameter ε represents aversion to inequality. On the choice of values for ε the *HDR 2005* (UNDP 2005: 344) states the following:

> *The value of ε is the size of the penalty for gender inequality. The larger the value, the more heavily a society is penalized for having inequalities. If ε = 0, gender inequality is not penalized (in this case the GDI would have the same value as the HDI). As ε increases towards infinity, more and more weight is given to the lesser achieving group. The value 2 is used in calculating the GDI…This value places a moderate penalty on gender inequality in achievement.*

When ε = 0, the above formula becomes the arithmetic mean weighted by female and male populations shares, and the resulting index should be equal to the component index for the whole population as used in HDI.[3] When, as in the calculations for the GDI, ε = 2, the above formula becomes the harmonic mean weighted by the population shares (UNDP 1995: 73).[4] Any difference between the female index and the male index – regardless of its direction – is penalized in the ED Index. This is to say that – for all three components – the Equally Distributed formula can only impose a penalty, not award a bonus.

Equally Distributed Health Index

The Equally Distributed Health Index (EDH) is calculated using female and male life expectancy data, primarily from the UN's Department of Economic and Social Affairs. The minimum and maximum life expectancies values used by the UNDP to normalize the Female and Male Health Indices are 27.5 and 87.5, and 22.5 and 82.5, respectively. The five-year difference between these ranges is attributed to the difference in women's and men's actual average life spans.[5] The harmonic mean of these two indices, weighted by their population shares, is then taken, resulting in the EDH:

$$(4)\ \text{Female-H-Index}_i = \frac{\text{Female LE}_i - 27.5 \text{ years}}{87.5 \text{ years} - 27.5 \text{ years}}$$

$$(5)\ \text{Male-H-Index}_i = \frac{\text{Male LE}_i - 22.5 \text{ years}}{82.5 \text{ years} - 22.5 \text{ years}}$$

$$(6)\ \text{EDH}_i = [(\text{FemalePopShare}_i * \text{Female-H-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-H-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

[3] The resulting index should be, but is not, equal to the component index for the whole population as used in HDI. I return to this point below.

[4] A harmonic mean is equal to $n/(1/x_1 + 1/x_2 + \ldots + 1/x_n)$, where n is the number of terms.

[5] For debate regarding the accuracy, meaning, and policy implications of the five-year gap in expected life spans see Dijkstra (2006) and Klasen (2006).

Equally Distributed Education Index

For most countries, *HDR 2005*'s Equally Distributed Education Index (EDE) relies on gendered adult literacy and combined gross school enrollment data from the United Nations Educational, Scientific and Cultural Organization's Institute for Statistics. Since the literacy and enrollment data are percentages, they are already normalized between 0 and 100.[6] The literacy and enrollment data for each gender are combined in a weighted average (with literacy receiving twice the weight of enrollment) to form the Female and Male Education Indices. The harmonic mean of these two indices, weighted by their population shares, is then taken to calculate the EDE:

$$(7)\ \text{Female-E-Index}_i = 2/3(\text{Female Literacy Index}_i) + 1/3(\text{Female Enrollment Index}_i)$$

$$(8)\ \text{Male-E-Index}_i = 2/3(\text{Male Literacy Index}_i) + 1/3(\text{Male Enrollment Index}_i)$$

$$(9)\ \text{EDE}_i = [(\text{FemalePopShare}_i * \text{Female-E-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-E-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

Equally Distributed Income Index

The calculation of the Equally Distributed Income Index (EDY) is somewhat more complex than that of the other component indices because data on income by gender are not readily available. In order to overcome this absence of data, the UNDP makes the assumption that the female share of a country's gross domestic product (GDP) is equal to the female share of wages.[7] The UNDP's (1995) female "estimated earned income" (Y_f) is, therefore, equal to the female share of the wage bill (S_f) times GDP divided by the female population (N_f):

$$(10)\ Y_f = \frac{S_f * GDP}{N_f}$$

Using data from the International Labour Organizations's (ILO's) LABORSTA database, the UNDP calculates the female share of the wage bill, using the ratio of female to male non-agricultural average hourly wages (W_f/W_m) as a proxy for the female to male ratio of all wages in a given country, and the ratio of female to male shares of the economically active population (EA_f/EA_m) as a proxy for the ratio of female to male paid hours worked. The female to male ratio of shares of the wage bill is the wage ratio weighted by the economically active population ratio:[8]

[6] The same result can, of course, be reached by using the normalization formula and applying 0 and 100 as the minimum and maximum values.

[7] GDP and GDP per capita refer to purchasing-power-parity (PPP) adjusted U.S. dollars throughout this chapter.

[8] If the female and male shares of the economically active population are equal ($EA_f/EA_m=1$), then the female to male ratio of shares of the wage bill (S_f/S_m) will equal the female to male wage ratio (W_f/W_m). If instead the female share of the economically active population is larger than the male share ($EA_f/EA_m>1$), then (S_f/S_m) will be greater

$$(11)\ \frac{S_f}{S_m} = \frac{W_f}{W_m} * \frac{EA_f}{EA_m}$$

Solving for the female and male shares of the wage bill:

$$(12)\ S_f = \frac{W_f/W_m * EA_f}{(W_f/W_m * EA_f) + EA_m}$$

$$(13)\ S_m = 1 - S_f$$

GDP is then multiplied by the female or male share of income and divided by the female or male population to result in that gender's estimated earned income:

$$(14)\ Y_f = \frac{S_f * GDP}{N_f}$$

$$(15)\ Y_m = \frac{S_m * GDP}{N_m}$$

In all countries, the resulting female estimated earned income is smaller than male estimated earned income.

The Female and Male Income Indices are calculated using a normalization formula designed to correct for diminishing marginal returns to income by taking the natural logarithms of the actual, minimum, and maximum values.[9] The minimum and maximum values used to normalize the Female and Male Income Indices are \$100 and \$40,000; this maximum level effectively acts as a cap on income in the male index, since five countries have male estimated earned incomes higher than \$40,000. The harmonic mean of these two indices, weighted by their population shares, is then taken to calculate the EDY:

$$(16)\ \text{Female-Y-Index}_i = \frac{\ln(\text{Female } Y_i) - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

$$(17)\ \text{Male-Y-Index}_i = \frac{\ln(\text{Male } Y_i) - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

$$(18)\ EDY_i = [(\text{FemalePopShare}_i * \text{Female-Y-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-Y-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

Table 1 reports the range of each Equally Distributed Index for 2003 as presented in *HDR 2005*.

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than (W_f/W_m), and if the female share of the economically active population is smaller than the male share $(EA_f/EA_m<1)$, then (S_f/S_m) will be smaller than (W_f/W_m).

[9] For more information on the logarithmic income conversion method now used in HDI and GDI, see Anand and Sen (2000).

Table 1: Component Index Data (2003)

	Health	Education	Income
ED Index high	*Japan 0.948*	*Australia, Belgium, Finland, Sweden, UK 0.993*	*Luxembourg, Norway 0.988*
Female high value	*Japan 85.4 years*	*Literacy: 39 countries 99.0% Enrollment: UK 133%*	*Luxembourg $34,890*
Male high value	*Iceland, Hong Kong 78.7 years*	*Literacy: 45 countries 99.0% Enrollment: Australia 114%*	*Luxembourg $89,883*
ED Index low	*Swaziland 0.114*	*Niger, Burkina Faso 0.154*	*Sierra Leone 0.249*
Female low value	*Swaziland 32.9 years*	*Literacy: Burkina Faso 8.1% Enrollment: Bhutan 14%*	*Sierra Leone $325*
Male low value	*Swaziland 32.1 years*	*Literacy: Burkina Faso 18.5% Enrollment: Bhutan 16%*	*Malawi $717*

Source: HDR 2005 and author's calculations using HDR 2005 data.

Gender-related Development Index

In the final step, GDI is calculated by taking the arithmetic mean of the EDLE, EDE, and EDY:

$$(19)\ GDI_i = (1/3)EDH_i + (1/3)EDE_i + (1/3)EDY_i$$

Using 2003 data, GDI values range from 0.961 in Norway to 0.271 in Niger, the same two countries that rank first and last in HDI (UNDP 2005). In between, a number of countries change rank due to greater or lesser degrees of gender inequality.

For more than ten years, GDI has been a powerful tool – and very nearly the only available tool – for comparing human well-being, adjusted for gender inequality, among countries and for observing how each country has changed over time. But does GDI present an accurate picture of gender-inequality-adjusted human development? If it doesn't, in what ways is it distorted? And what are the consequences of an image that is blurred or out of proportion?

Critiques of GDI

Many serious questions have been raised in the development economics literature about just how accurate a measure of gender-inequality-adjusted human development GDI really is. Several of the critiques that follow are new to the literature, notably, a detailed accounting of data assumptions used in calculating GDI, and demonstrations of the existence of three biases stemming from: an inconsistent use of income caps; a hidden penalty resulting from a reversal in the order of operations; and a gender mortality bias introduced through the female and male population shares. Other topics addressed in this section are restatements of critiques received from the literature that I have illustrated using original techniques and the most recent UNDP data. Both original and received critiques have been included to provide a comprehensive treatment of GDI, its strengths, and its weaknesses.

Assessing data quality

Any index is only as accurate as its underlying data. The data used to calculate HDI and GDI are much more likely to be available for the two genders combined than for each gender individually. In calculating the GDI, *HDR 2005* eliminates 37 of the 177 countries for which HDI values are available due to lack of gender-specific data and makes a number of assumptions in order to either present GDIs for certain countries in the absence of complete data or to smooth over the rough spots where the actual data fail to conform to their assumed range.[10]

A general critique of GDI's data availability and reliability has been provided by Bardhan and Klasen (1999), including questions about the quality of life expectancy data where no official registration of birth or death exists, and infant deaths, especially, tend to go unreported. Life expectancy is, however, the only component for which there are gendered data for every country that is included in GDI. These data are more likely to be available because life expectancy at birth is a prediction about the expected life spans of children born in a given year, not a measurement of the average age of death of those that have died.

In addition, the UNDP (2005) makes assumptions about certain countries for which gendered data are missing or outside of the assumed range, and, in a few cases, where actual data do exist and are within the assumed range. Twenty-four industrialized countries – the top 21 countries by HDI rank plus Portugal, the Republic of Korea, and the Czech Republic – are simply assumed by the UNDP, in the absence of any reference to available data, to have female and male adult literacy rates of 99.0 percent.[11]

Female and male adult literacy rates for an additional twelve countries are rounded down from their reported rates to 99.0 percent, and for Greece are rounded up to 99.0 percent from 88.3 percent for females and 94.0 percent for males. Uzbekistan's male literacy rate is reported to be 99.6 percent, which is not rounded down in *HDR 2005*, giving it the highest male literacy rate in the world for UNDP purposes. Five more countries have literacy rates that are rounded down to 99.0 percent for males only.

In order to calculate the "combined gross school enrollment" used in GDI, the number of students enrolled in primary, secondary, and tertiary schools is divided by the number of people in each country's normal age groups for those grades. The presence of students recorded as living in a different country from the one in which they attend school, as well as the existence of any students older than the normal age of the highest tertiary school grade, can return a combined gross school enrollment of greater than 100 percent. The UNDP (2005) has chosen to round these numbers down to 100 percent for the purposes of calculating GDI. Enrollment rates

[10] Five countries are eliminated for lack of gendered life expectancy data, fifteen for lack of adult literacy rates by gender (including ten countries not previously excluded for lack of life expectancy data), thirteen for lack of gendered enrollment data (including ten countries not previous excluded for lack of data described above), and twenty-three for lack of data necessary to calculate estimated earned income (twelve of which were not previously excluded for missing life expectancy or education data).

[11] Of these 24 countries, the UNDP (2005) reports literacy rates for the whole population (women and men combined) in only four countries: Italy (98.5 percent), Spain (97.7 percent), Portugal (92.5 percent), and the Republic of Korea (97.9 percent).

are rounded down for men in five and women in nine countries, all of which are classified as by the UNDP as high human development. Actual enrollment rates, before rounding down are as high as 133 percent for females in the United Kingdom and 114 percent for males in Australia.

Finally, the data used by the UNDP to estimate gender-specific incomes are not in fact available for many countries. *HDR 2005* (UNDP 2005: 346) does not make explicit the extent of the assumptions used for missing data points in calculating estimated earned income, but notes that, "Where data on the wage ratio are not available, a value of 75% is used." *HDR 1995* stated that the ratio of female to male non-agricultural wages was only available for 55 out of 130 countries, and that the average ratio for these 55 countries – 75 percent – was applied to the remaining countries. In *HDR 2005*, data for the wage ratio and the shares of the economically active population by gender are cited as coming from the ILO's LABORSTA database for 2005 and 2002, respectively. Examination of the publicly-available LABORSTA data for those years, however, showed only nine countries with data for wage ratios and 69 with data for the share of economically active population by gender. In the nine countries for which data was available, wage ratios ranged from 0.50 in Japan to 0.86 in New Zealand.[12]

In their review of GDI as a prelude to the construction of an African-GDI on behalf of Economic Commission for Africa, Charmes and Wieringa (2003: 428) question the use of international data sets in GDI, stating, "Nobody will contest that the most detailed and recent data are available at the national level, because their gathering and entry into an international database takes time and requires full examination and possibly adaptation." They suggest that GDI would be more accurate if it were calculated at the national level.

For the data on which GDI is based, what Charmes and Wieringa refer to as the "adaptation" of data is pervasive. Without these data adaptations, of course, GDI could only be presented for a small subset of countries. Comparing GDI values for a large set of countries provides valuable information, but when data adjustments assume optimistically high values in developed countries in the absence of data or assume values based on elaborate calculations and very little data, the *HDRs* should provide detailed explanations justifying these choices.

Choosing the right components

Just because life expectancy, literacy, school enrollment, and income are used to measure well-being in the HDI does not mean than the gender gaps in these variables are necessarily the best data for illuminating the overall disparity in human development between women and men. Choosing which components to include, and which to exclude, in any measure of human well-being, requires a delicate balance of political, practical, and even ethical concerns. Several critiques of GDI have pointed out ways in which its data could be improved, including by starting over to redesign it from scratch:

> *Had the UNDP attempted an independent formulation of the GDI, deriving its framework from the experience of developing countries, it could not but have taken note of indicators such as*

[12] For a discussion of the disparate definitions of labor force participation and earnings used within and between countries see Prabhu et al. (1996).

> *access to fuel and water, property rights, incidents of violence against women, etc. While an index cannot be expected to capture adequately the subtle yet all pervading discrimination against women in various spheres, the UNDP's effort would have been more meaningful had it attempted constructing a comprehensive index that is sensitive to the special problems faced by women in developing countries. (Prabhu et al. 1996: 72)*

Bardhan and Klasen (2000: 194) make a similar argument about constructing a GDI in a way that would highlight gender inequality in rich countries. They suggest that variables such as gender bias in education choices, the quality of education, and access to employment, training, job advancement, or leisure time would better demonstrate a more "subtle" form of gender inequality.

With regard to GDI's measures of life expectancy and education, Bardhan and Klasen (1999: 991-993) argue for the inclusion of both "stock" and "flow" measures to balance the effects of past and present discrimination against women (where "stock" measures are interpreted as those that capture elements of past discrimination), and they point out that while GDI's education component includes the stock measure of adult literacy as well as the "flow" measure of school enrollment, life expectancy only measures current, and projected future, discrimination (see also Dijkstra and Hanmer 2000: 50, 57).[13] According to Bardhan and Klasen (1999: 1003 n.13), GDI ignores biases in past gender mortality, where the impact could only be observed in cohorts older than the one born in the current year. They suggest that it may be "ethically dubious not to consider victims of discrimination simply because they have died as a result of this discrimination," a point to which I return below. Also absent from GDI's life expectancy measure is the impact of pre-natal discrimination (i.e., sex-selective abortion) (Klasen 2006: 248).[14]

Many critiques of GDI, including those related to data appropriateness, focus a substantial share of their attention on the EDY and GDI's procedure for estimating gendered income. These concerns are addressed in greater detail in the following two sections.

Measuring gendered income

Unlike the other components in GDI, gendered income is a rough estimate. Several critiques have questioned the appropriateness of using non-agricultural wages together with labor force participation as gender weights for GDP per capita.[15] The ratio of female to male non-agricultural wages approximates the ratio of all female to male wages only if agricultural and non-agricultural wages are similar and the informal sector (where wages are not recorded) is very small. The ratio of female to male labor force participation approximates the ratio of female to male paid hours worked only if women and men have the same average number of paid hours of

[13] The HDR uses life expectancy data from the UN's World Population Prospects: The 2004 Revision Population Database, which defines life expectancy at birth as "the average number of years of life expected by a hypothetical [5-year] cohort of individuals who would be subject during all their lives to the mortality rates of a given period."
[14] For other, more general discussions of which variables to include when measuring women's well-being see Robeyns (2003), Austen et al. (2003), and Charmes and Wieringa (2003).
[15] See Bardhan and Klasen (1999, 2000); Charmes and Wiering (2003); Dijkstra (2002, 2006); Dijkstra and Hanmer (2000); Klasen (2006); and Prabhu et al. (1996).

work. These two ratios multiplied together approximate the ratio of female to male income only if there are no non-wage sources of income – no home production, and no investment or rental income.

Applying the resulting female or male shares of income to GDP divided by the female or male population (the UNDP's formula for estimated earned income) approximates women and men's standard of living only if there are no non-market goods or services, public goods are equally distributed with respect to gender, women and men live separately (or with no shared income), children are wards of the state, and women and men enjoy equal amounts of leisure time, or if gender-specific effects in these arenas mirror the calculated earned income shares. The problem of disaggregating household income in such a way as to make a meaningful proxy for material well-being by gender is not well-suited to the kinds of broadly available data sets found in the *HDR*s.[16] To the extent that women and men have claims on other sources of income and wealth, neither the level of consumption nor the standard of living can be inferred from estimated gendered income alone. Women and men's relative contributions to household and children's expenses are another important consideration, as is the direct impact of household labor on living standards (Bardhan and Klasen 1999: 992-993).

One suggestion for improving the income component of GDI is to replace gendered "estimated earned income" with some other relevant measure. For example, the UNDP's Human Poverty Index for developing countries (HPI-1) measures deprivation in living standards as the percentage of the population without sustainable access to an improved water source and the percentage of children under-weight for their age; the HPI-2 (for industrialized countries) uses the percentage of people living below the poverty line. Data that are not currently available for many countries – but perhaps could be made available with encouragement and funding from the UNDP and other international institutions – might better distinguish female from male material well-being, like the percentage of under-weight children by gender, or the percentage of people living in poverty by gender.

Discounting gendered income

In the field of economics, income is commonly assumed to have a diminishing marginal utility, that is, the more you have, the less each new dollar means to you. In the EDY, as in the HDI's income component, estimated earned income is capped at $40,000 and then discounted by taking its natural logarithm (so that a doubling of income has the same effect on GDI regardless of the level of income). Both the application of the income cap and the discounting procedure present special problems in GDI. In addition, the average gender-inequality penalty to the income component is larger than that of life expectancy or education, with the result that gender disparities in income dominate the total gender-inequality or GDI penalty.

[16] See also Iversen (2003) on intra-household inequality, Cantillon and Nolan (2001) on poverty within households, and Folbre (2006) on including the care economy in measures of human development.

Inconsistent income cap

Five countries have male estimated earned incomes over $40,000 (female income is below $40,000 in all countries included in GDI). Only one of these five, Luxembourg, is actually capped at $40,000; the other four – Austria, Ireland, Norway, and the United States – are not capped, resulting in Male Income Indices greater than 1.000.[17] Ignoring the $40,000 income cap in countries where estimated male income is greater than $40,000 maintains the greatest consistency with HDI. Applying the income cap (as the GDI formula dictates) in countries, like Luxembourg, where both GDP per capita and estimated male income exceed $40,000, however, both fails to maintain consistency with HDI[18] and artificially shrinks the gap between female and male income, thereby decreasing the gender-inequality penalty.

A method that maintains some consistency with HDI without shrinking gender gaps in income is to use $40,000 minus one-half the gender gap to calculate the female income index and $40,000 plus one-half the gender gap for the male income index. In this way, both Luxembourg's mean income level as assumed in HDI, $40,000, and the size of the gap between female and male income, $54,993, are considered in the calculation of GDI. The effect would be to reduce Luxembourg's GDI from 0.944 to 0.923, and its GDI rank from seventh to twentieth, below Germany and above Spain. While this problem is currently limited to one country's GDI, several other countries' GDP per capitas are rapidly approaching $40,000.

Hidden penalty

A second concern is with GDI's adjustment for the diminishing marginal utility of income. Unaccounted for interactions exist between the discounting effect and the gender-inequality penalty effect. The UNDP (2005: 344) states that when ε is set equal to zero, GDI reverts to HDI. But in fact, HDI is not equal to GDI with ε = 0 (hereafter referred to as the Weighted-HDI).[19]

Table 2 divides the total GDI penalty (or the difference between HDI and GDI) into two steps: the difference between HDI and Weighted-HDI, and the difference between Weighted-HDI and GDI. With three components and two steps, there are six possible sources of differences that together make up the total GDI penalty.[20] If HDI and Weighted-HDI were equal, then 100 percent of the penalty would come from the difference between Weighted-HDI and GDI.[21] Instead, 45 percent of the penalty is the result of differences between HDI and Weighted-HDI, and nearly all of this disparity stems from the income component.

[17] This exception to the GDI formula is not explained in the *HDRs* (UNDP 2005).
[18] Using this method, when ε = 0, Luxembourg's Equally Distributed Income Index would be much small than its income index in HDI.
[19] Weighted-HDI is GDI with ε = 0, which, according to the UNDP (2005), is equal to the HDI, or more accurately, the HDI weighted by the female and male population shares. The population shares should be implicit in each of the HDI components.
[20] Note that each of the six sub-penalties is divided by three before being combined to form the total penalty.
[21] If Penalty = HDI – $GDI^{(\varepsilon = 2)}$ and HDI = $GDI^{(\varepsilon = 0)}$, then Penalty should = $GDI^{(\varepsilon = 0)} – GDI^{(\varepsilon = 2)}$. Instead, Penalty = (HDI – $GDI^{(\varepsilon = 0)}$) + ($GDI^{(\varepsilon = 0)} – GDI^{(\varepsilon = 2)}$).

Table 2: Average share of penalty by component (2003)

HDI less Weighted HDI			
Health	**Education**	**Income**	**Total Penalty**
0.000	0.000	0.011	0.004
-1.4%	*-1.0%*	*47.8%*	*45.3%*
Weighted HDI less GDI			
Health	**Education**	**Income**	**Total Penalty**
0.001	0.005	0.006	0.004
5.1%	*22.7%*	*26.9%*	*54.7%*
HDI less GDI			
Health	**Education**	**Income**	**Total Penalty**
0.001	0.005	0.017	0.008
3.6%	*21.7%*	*74.7%*	*100.0%*

Source: Author's calculations using HDR 2005 data.

In the regular income index used to calculate HDI, GDP per capita is, in effect, the average of female and male incomes weighted by gendered population shares. The order of operations used to calculate the income component in HDI is, therefore, first a weighted average, then a log transformation for discounting, then normalization. In GDI and Weighted-HDI, however, the order of operations is first log transformation, then normalization, then weighted average. This is of concern because the natural log of a weighted average is not equal to the weighted average of a natural log.[22] (For a demonstration of this effect see Appendix C).

In Tables 3 and 4 below, all three indices have had their orders of calculation reshuffled to more closely approximate HDI. For EDH and EDE, a harmonic mean, weighted by the female and male populations shares, is taken of the values themselves (for Weighted-HDI this becomes the weighted arithmetic mean). These penalized values are then normalized using the regular ranges or goalposts.[23] For EDE, the weighted harmonic mean of both literacy and enrollment is taken before normalization; then the two components are averaged using the normal two to one weighting. For EDY, first the weighted harmonic mean is take of female and male income, then the penalized income is discounted and the normalization formula is applied.

Using this new order of operations, Weighted-HDI is much closer in value to HDI, and the gap between HDI and GDI has gotten slightly larger (compare Table 4 to Table 2). EDH is the only

[22] From 1995 to 1998, GDI was calculated using a different discounting method, which was applied after the weighting and penalty procedure. In *HDR 1999*, GDI was changed in both the discounting method and the order of operations to the current formula. The latter change was prompted by Bardhan and Klasen's (1999) argument that applying the penalty before discounting resulted in disproportionately higher penalties for richer countries (993). Dijkstra (2002, 2006) has argued that Bardhan and Klasen's critique was incorrect and that discounting before applying the penalty in effect discounts the gaps as well as the values, thereby reducing the overall penalty (308-309).

[23] Except in EDH, where female life expectancy has five years subtracted from it and the male goalposts, 22.5 and 82.5, are used; for Weighted-HDI, five years is not subtracted and the goalposts are the regular 25 and 85.

component where HDI still diverges from Weighted-HDI after the change in order of operations. This result is a good example of how small the numerical differences are between HDI and GDI. Life expectancy as reported in the *HDR 2005* and life expectancy calculated in the recalculated Weighted-HDI are the same to the tenth of a year in almost all cases, and that is all the significant figures that really exist here.

Table 3: Share of penalty by component after adjustment of calculation order (2003)

HDI less Weighted HDI			
Health	**Education**	**Income**	**Total Penalty**
-0.001	0.000	0.000	0.000
-2.4%	*-0.8%*	*0.8%*	*-2.4%*
Weighted HDI less GDI			
Health	**Education**	**Income**	**Total Penalty**
0.001	0.006	0.022	0.010
3.3%	*21.3%*	*77.8%*	*102.4%*
HDI less GDI			
Health	**Education**	**Income**	**Total Penalty**
0.000	0.006	0.022	0.009
0.9%	*20.5%*	*78.6%*	*100.0%*

Source: Author's calculations using HDR 2005 data.

Table 4: Adjusted GDI with re-ordering of calculations (2003), selected countries

GDI rank	Country	GDI	adj- GDI	Change in GDI	Change in rank
41	Bahrain	0.836	0.830	0.006	-2
61	Oman	0.758	0.748	0.010	-3
65	Saudi Arabia	0.749	0.740	0.009	-3
76	Belize	0.734	0.728	0.006	0

Source: Author's calculations using HDR 2005 data.

Table 4 shows the results of adjusting GDI by reordering the calculations for selected countries. The resulting adjusted-GDI is, on average, smaller by 0.002, although 30 countries stay the same and six become slightly larger. The largest deductions are for Oman (0.010), Saudi Arabia (0.009), Bahrain (0.006), and Belize (0.006). The effect of this adjustment on GDI ranks is far less dramatic, since almost all GDI values change in the same direction.

Imbalanced penalties

GDI's three component indices are combined together in a simple, unweighted average. On the surface this implies a balance of importance among the health, education, and income gender-inequality penalties, but implicit weights may exist if the mean or variance of the component

female to male gaps are imbalanced (Dijkstra 2002: 313). As shown in Table 2 above, the total gender-inequality penalty, or the difference between HDI and GDI, is 0.008, of which life expectancy accounts for 3.6 percent, education 21.7 percent, and income 74.7 percent.[24]

Bardhan and Klasen (1999: 990) used the same basic method to critique the uneven implicit weights given to life expectancy, education, and income in the overall GDI penalty using data from *HDR 1995*: "While the aim and underlying premise of the GDI (to see gender inequality as a human development issue and not primarily a 'women's issue') is to be welcomed, it appears that the current version of GDI is largely driven by gaps in one component, the earned-income component." In their study, the percentage of the total penalty that was accounted for by each term was: 1.0% health; 14.0% education; and 85.0% income. According to Bardhan and Klasen, this bias in GDI resulted in the assignment of higher penalties to countries whose gender inequality stemmed from income disparities – in the Middle East and North Africa – and lower penalties to countries whose gender inequality stemmed from disparities in life expectancy or education – Southeast Asia, Sub-Saharan Africa, Eastern Europe, and Russia (1999: 989-994; 2000: 194).

While the imbalance is somewhat smaller in the more recent data, income continues to drown out the effects of gender disparities in life expectancy and education. Dijkstra (2006) and Klasen (2006) suggest standardizing all three components (which would have the unfortunate effect of making the GDI no longer comparable across years), choosing a higher ε for the life expectancy component, or increasing the minimum life expectancy value by ten years in the normalization formula. Raising the minimum life expectancy by just two and one-half years (to 30 years for women and 25 years for men) does increase the share of the GDI penalty attributable to gender disparities in life expectancy (see Table 5), but limits the comparability between HDI and GDI.

Table 5: Adjusted average share of penalty by component (2003)

HDI less GDI

Health	Education	Income	Total Penalty
0.015	0.005	0.017	0.013
40.6%	*13.4%*	*46.1%*	*100.0%*

Source: Author's calculations using HDR 2005 data.

Valuing gender inequality

The value assigned to the parameter ε is meant to result in GDI penalties that are of a size that seems consistent with gender inequality's negative impact on well-being in each country. When the UNDP (1995: 73) first introduced the GDI in 1995, it described ε as an "adjustable" parameter:

[24] See also Klasen (2006); note that Klasen is measuring the gender penalty as the difference between the Weighted-HDI and the GDI, whereas here the penalty is the difference between the HDI and GDI.

> *[E]ach society can choose a specific value for its "aversion to gender inequality" (ε), depending on where it starts and what goals it wants to achieve over what time period. In previous [HDRs], ε was implicitly assumed to be zero – that is, no policy preference for gender equality was adopted. But policy-makers must make an explicit choice of the weight they wish to assign to their preference for gender equality…The illustrative calculations of the GDI…are based on ε = 2 (harmonic mean), which expresses a moderate degree of inequality aversion. This is only to show that, even with modest weights, the profile of gender inequality looks fairly bad in most countries.*

The suggestion that policy-makers should first assign their own level of aversion to gender inequality and then recalculate the GDI before comparing various countries' GDIs to their own or evaluating their own country's progress in GDI seems somewhat unrealistic. An argument could be made that policy-makers in some countries seem to have little or no aversion to gender inequality, and that some actively seek to perpetuate gender disparities. The adjustable quality is no longer mentioned in more recent *HDR*s, leaving ε = 2 as the *de facto* value. The Equally Distributed Index formula, therefore, can be restated in a more transparent form:

$$(22)\ \text{ED-Index}_i = \frac{1}{\frac{\text{FemalePopShare}_i}{\text{Female-Index}_i} + \frac{\text{MalePopShare}_i}{\text{Male-Index}_i}}$$

The average penalty assigned for gender inequality in calculating GDI is just 0.008 (compared to HDI's range of 0.963 to 0.281). The loss of 0.008 of HDI is comparable to one of any of the following: 1.5 fewer years of average life expectancy; 3.5 fewer percentage points in the literacy rate; or 7.0 fewer percentage points in the school enrollment rate. Because of the adjustment for diminishing marginal returns, an equivalent reduction in GDP per capita would depend on the income level, for example, either from $40,000 to $34,500 or from $10,000 to $8,700.

The largest penalty – 0.040 for Yemen – is just a little bit larger than the size of the difference between the HDIs of Norway (ranked first by HDI) and Spain (ranked twenty-first).[25] Using the language of the *HDR*s, if society placed the "moderate" value on gender inequality assumed in GDI, then the decrease in Yemen's human development due to gender inequality – a country where on average women live less than three years longer than men (compared to the "normal" 5 years), 29 percent of women can read compared to 70 percent of men, 41 percent of young women are enrolled in school compared to 69 percent of men, and the average woman earns $400 a year compared to $1300 for men – would have the same impact on well-being as the choice of living in Spain instead of Norway.

GDI penalties range from zero percent of HDI in nine countries to 8.2 percent in Yemen, with an average penalty of 1.3 percent. Is this a "moderate" degree of inequality aversion? And if it is, can the amount that society's well-being suffers as a result of gender inequality accurately be described as "moderate"? Table 6 below compares countries' ranks for Weighted-HDI (ε = 0), GDI (ε = 2), GDI with ε = 10, and GDI with ε = 100 for the ten countries with the lowest ranks

[25] Throughout this chapter, HDI ranks have been recalculated to exclude 37 countries left out of GDI for lack of gendered data.

Table 6: Rankings of GDIs with higher penalty factors (2003), selected countries

Rank	Weighted HDI	GDI	GDI ε = 10	GDI ε = 100
131	Congo, D.R.	Congo, D.R.	Burundi	Zambia
132	Mozambique	Burundi	Congo, D.R.	Congo, D.R.
133	Burundi	Mozambique	Mozambique	Mozambique
134	Ethiopia	Ethiopia	Ethiopia	Ethiopia
135	Guinea-Bissau	Guinea-Bissau	Mali	Mali
136	Chad	Mali	Burkina Faso	Burkina Faso
137	Mali	Chad	Chad	Chad
138	Burkina Faso	Burkina Faso	Guinea-Bissau	Guinea-Bissau
139	Sierra Leone	Sierra Leone	Niger	Sierra Leone
140	Niger	Niger	Sierra Leone	Niger

Source: Author's calculations using HDR 2005 data.

by each of these measures. (For results for all 140 countries see Appendix D). The average penalty for GDI with ε = 10 is 3.5 percent and for GDI with ε = 100 is 6.2 percent. For Yemen, the GDI penalty reaches 18.3 percent with ε = 10 and 22.0 percent with ε = 100.

In past *HDR*s, the UNDP has referred to gender inequality as a "persistent neglect to the creativity and productivity of half of humanity," (1995: 23) and has stated that, "Of the many inequalities in human development, the most striking is that along gender lines." (1991: 92) The best value for ε is, of course, subjective, but an ε value larger than that currently used in GDI – and an average penalty for gender inequality larger than one percent of HDI – would seem better aligned with the size of the burden of gender inequality portrayed in the *HDR*s.[26]

Regarding the direction of penalties

Any difference between female and male component indices – regardless of its direction – is penalized by a reduction in the Equally Distributed Index formula. This is to say that, even when the female index is higher than the male index, a penalty will nonetheless be assessed.[27] This gender-blind feature of GDI does not appear to have been the intention of UNDP (1995: 73) in electing to use this particular measure of human development, as evidenced by this description of what value GDI takes as ε approaches infinity: "In the extreme case, if ε = infinity, only achievements of women get a positive weight, and the relative achievements of men are ignored." This, of course, could be true only if female indices were exclusively lower than male indices.

[26] Other critiques of the UNDP's choice of values for ε in GDI include Bardhan and Klasen 1999, and Dijkstra and Hanmer 2000. For further discussion on the choice of ε in this type of welfare measure see Grün and Klasen (2003).
[27] See Dijkstra (2002); Dijkstra and Hanmer (2000); Klasen (2006);and UNDP (1995: 74).

To be clear, a female advantage in one component does not offset a male advantage in another. Instead, any gender inequality – regardless of direction – adds to the GDI penalty.[28] This renders the meaning of GDI somewhat difficult to interpret. The idea that male disadvantages are added on top of female disadvantages to sum up to a final gender inequality penalty is complex and counter-intuitive. It seems at odds both with what someone who has not read the technical notes to the HDR is likely to assume "gender inequality" means and with the UNDP's own rhetoric, in which the terms "gender inequality" and men's advantages over women are used interchangeably.[29]

For 2003, 77 out of 140 countries have at least one component in which the female index is higher than the male index (see Appendix Table E). When female and male component indices are used independently to calculate Female-HDIs and Male-HDIs, seven countries have higher Female than Male-HDIs: Luxembourg and six former Soviet Republics.[30] The meaning of the resulting GDI penalty, and of GDI itself, is unclear – especially in countries in which females are better off than males by some component indices but worse off by others. Table 7 is a correlation matrix for the gender-inequality penalties associated with the health, education, and income components; correlation between the three component penalties is low, and two of the three pairwise correlations are negative.

Table 7: Correlation matrix of component penalties (2003)

	H penalty	E penalty	Y penalty
H penalty	1.000		
E penalty	0.028	1.000	
Y penalty	-0.240	-0.197	1.000

Source: Author's calculations using HDR 2005 data

Rewarding gender mortality bias

Each Equally Distributed Index is weighted by the female and male population shares. The inclusion of unequal population shares in the ED formulas introduces a bias (not unlike a perverse incentive) for low female to male sex ratios, where a low female share of the population gives a correspondingly low weight to women's lower index values, thereby underestimating gender disparities.[31] In addition, when males have the lower index values, the low female population share result in a greater emphasis on male disadvantages. (For a demonstration of these effects see Appendix F.)

This bias could be called the "missing women" effect after Amartya Sen's (1990) observations about gender mortality bias. Missing women are the additional women and girls who, but for the existence of past and present gender mortality bias, would be alive today. Sen used the sex ratio

[28] A technical note to *HDR 1995* (UNDP 1995: 131) recognizes this issue, but concludes that it is not an important concern because it occurs in very few countries and those countries are at the highest levels of human development.
[29] See Schüler (2006) on misinterpretations of GDI in scholarly articles as well as UNDP reports.
[30] For further discussion of this topic see Klasen (2006).
[31] See also Kanbur and Mukherjee (2003) and Klasen (2006).

in Sub-Saharan African, 102 females for every 100 males (or a female population share of 0.505), as the sex ratio that would be expected under conditions of low gender mortality bias. Comparing this expected sex ratio to the actual sex ratios in other regions, he found a deficit of 11 percent. One hundred million of the women that would be expected in South Asia, West Asia, China, and North Africa were missing. All of the countries with missing women are rewarded in terms of their GDI value whenever the remaining women are disadvantaged in health, education, or income.

If Sen's expected gender population shares are used in the calculation of GDI in place of each country's actual population shares, nine countries' GDIs increase by 0.001 and 95 countries' GDIs stay constant. The remaining 36 countries have lower GDIs using Sen's population shares; the change in GDI after this adjustment is the size of the bonus given to these countries' GDIs for gender mortality bias. The countries that receive the highest missing women bonuses are shown in Table 8 below.

Table 8: Adjusted GDI with Sen's population shares (2003), selected countries

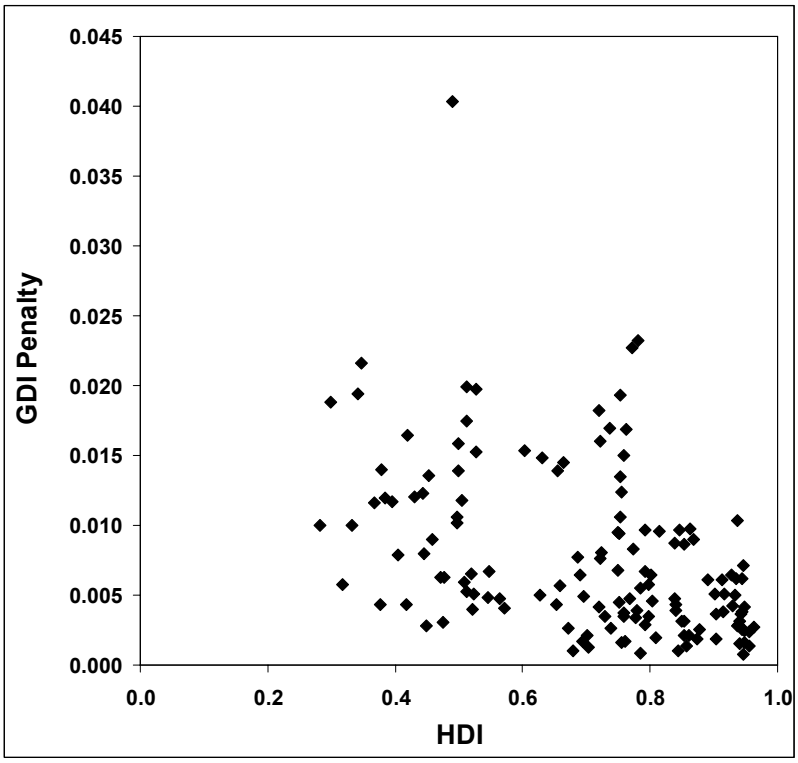
GDI rank	Country	Female share of population	GDI	adjusted-GDI	GDI less adjusted-GDI	GDI rank less adjusted-GDI rank
39	Kuwait	0.400	0.843	0.837	0.006	-1
41	Bahrain	0.430	0.836	0.830	0.007	-2
61	Oman	0.438	0.758	0.749	0.009	-3
65	Saudi Arabia	0.460	0.749	0.743	0.006	-3
73	Jordan	0.480	0.740	0.737	0.002	-1
98	India	0.487	0.587	0.585	0.002	0
103	Papua New Guinea	0.484	0.518	0.516	0.002	0
107	Pakistan	0.485	0.508	0.505	0.003	-1
121	Yemen	0.493	0.449	0.447	0.002	-1
128	Côte d'Ivoire	0.492	0.403	0.401	0.002	0

Source: Author's calculations using HDR 2005 data

Identifying the differences from HDI

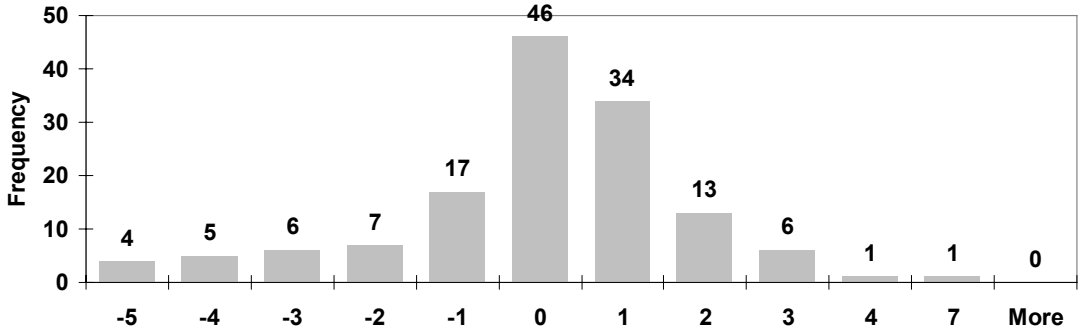
After the data are chosen, gendered income is estimated, penalties are assigned, and components are averaged together, the resulting GDI should be different from HDI – a difference that is meant to represent the extent of loss of well-being due to gender inequality in each country. Figure 1 is a scatterplot of GDI penalties versus HDI values using 2003 data. Most GDI penalties are very small, which suggests that GDI values are dominated by the information in HDI; that is, the new information meant to differentiate GDI, and to emphasize the impact of gender inequality on all human well-being, is being overshadowed by the rest of the HDI. In thirteen countries the difference between HDI and GDI is less than one one-thousandth, and therefore not appreciable in the three significant figures in this data; in a further 22 countries, the GDI penalty is 0.001.

Figure 1: GDI Penalties versus HDI (2003)



Source: HDR 2005 and author's calculations using HDR 2005 data.

Figure 2: Histogram of Rank Differences (HDI rank less GDI rank) (2003)



Source: Author's calculations using HDR 2005 data.

When GDI ranks are compared to HDI ranks, the largest changes in rank are for Sri Lanka (GDI is 7 ranks higher than HDI); Guyana (4 ranks higher); Belize, Oman, Peru, and Saudi Arabia (5 ranks lower); and Ireland, Lebanon, Pakistan, Paraguay, and Yemen (4 ranks lower). For 46 out of the 140 countries, there is no change in rank (see Figure 2 above), and for 51 the difference is only one rank up or down.

GDI has a noticeable effect on HDI ranks, but very little impact on HDI values. One can only hope that society's aversion to gender inequality is greater than that represented by the penalty to GDI.

Simplifying the GDI

In introducing the GDI, *HDR 1995* (UNDP 1995: 72) emphasized its practical use to policy-makers, stating:

> *[GDI is] suggested to capture gender disparities and their adverse effects on social progress. Capturing such a complex reality in a single, simple index is not easy. But a beginning must be made, however limited, to place the problem of gender inequality firmly on the social agenda. For policy-makers particularly, it is useful to look at composite measures – for their own countries and for others – to draw policy conclusions about critical shortfalls in gender capabilities or opportunities, and about priorities to consider in their plans of action.*

A clear preference for a clearer, simpler, more straightforward measure has been expressed in several critiques of the GDI.[32] Charmes and Wieringa (2003: 429-30), in the context of creating an African-GDI, state that, "The complexity of this measure of calculation, coupled with the fact that its computation is based on international data sets, effectively means that the control of the data is out of reach of many NGOs in developing countries." Likewise, Dijkstra and Hanmer (2000: 45) remark that, "[W]hether ε is set equal to infinity, one, or two, none of the resulting measures translates readily into an indicator of the position of women which can be easily used and understood by nonspecialists and policy-makers." More recently, Schüler (2006) describes how GDI has often been mistaken for a measure of gender inequality in academic articles and even in UNDP reports.

GDI is not computationally simple; its calculation is clearly more complicated than HDI, requiring several extra steps and the use of exponents in a penalty formula the effect of which is far from transparent. Neither is GDI conceptually simple; the meaning of an index that adds male penalties to female penalties to result in a gender inequality penalty is obscure. Finally, GDI's use or interpretation is not simple; GDI values are very nearly the same as HDI values. What interpretation can these small differences be given with regards to the state of countries' gender-inequality-adjusted well-being, except that disparities between women and men have little or no effect on human development?

[32] See Bardhan and Klasen (1999); Charmes and Wieringa (2003); Dijkstra (2006); Dijkstra and Hanmer (2000); Klasen (2006); and Schüler (2006).

Conclusions

GDI is a valuable, but flawed, tool. This chapter has endeavored to critically examine GDI's shortcomings in its role as a measure of human development penalized for the extent of gender inequality. The main critiques set out here may be summarized as:

- GDI's underlying data suffer from numerous deficiencies in data availability that have made necessary numerous assumptions in place of actual data values. For most of the source data, these assumed data values are the exception, but in the case of the data used to estimate female and male earned incomes, it may be that more data are assumed than measured.

- Life expectancy, literacy, school enrollment, and income may not be the best collection of capabilities with which to observe gender disparities. Other possible components that might be more appropriate to the task include: access to fuel and water; property rights; incidents of violence against women; gender bias in education choices; the quality of education; access to employment, training, and job advancement; and access to leisure time.

- The method used to estimate female and male earned incomes ignores: the existence of self-employment; biases in women and men's access to full-time paid work; and the complex nature of intrahousehold distribution of money, goods, and labor.

- The diminishing marginal utility of income is represented in GDI by a cap on income at $40,000 that is applied to one country, but not to others, and by taking the natural logarithm of income. The log of income is taken before the gender inequality penalty is calculated, whereas in HDI taking the log comes in the final step. This difference in the order of operations between HDI and GDI creates a hidden and unintended penalty to GDI.

- Life expectancy, education, and income do not make up equal shares of the value of GDI. Instead, gender disparities in income dominate the GDI penalty.

- In the calculation of GDI, society is assumed to have an aversion to inequality that is equal, on average, to one percent of the value of HDI. This implicit assessment of gender inequality's significance to human well-being seems out of step with the UNDP's own rhetoric regarding the enormous impact of disparities between women and men.

- Female and male disadvantages in capabilities are treated identically in GDI, so that penalties for female deprivations are added to penalties for male deprivations to form a final gender inequality penalty. The meaning of gender inequality in this sense is difficult to understand, and cannot be at all obvious to the casual user of GDI.

- GDI contains a "missing women," or gender mortality bias. The fewer women in a given country, the less the deprivation of those remaining women counts in GDI's method of measuring human development.

- While GDI ranks differ from those of HDI, GDI values are very nearly the same as HDI values. A measure of human development adjusted for gender inequality that is barely distinguishable from a measure of human development that is neutral to gender inequality seems deeply flawed.

- GDI requires a specialist to calculate and interpret it. A simpler, more straightforward measure would be preferable for the purposes of policy-makers and development professionals.

Several of these critiques are new contributions to the human development literature: the detailed accounting of data assumptions used in calculating GDI, and the demonstrations of the inconsistent use of income caps, the hidden penalty resulting from a reversal in the order of operations, and the gender mortality bias introduced through the female and male population shares.

A measure of human well-being that takes gender inequality into account is an essential element of the portrait of human development contained in the *HDR*s. Klasen (2006: 260) concludes a recent critique of GDI saying:

> *I believe it is not useful to continue reporting the GDI as the main indicator for gender-related human development. It is frequently misunderstood and it is beset with serious conceptual and empirical problems. At the same time, it would be useful to re-consider a revised GDI within a range of distribution-sensitive HDIs.*

Like Klasen, I believe that GDI is seriously flawed in its current formulation, and that it should be replaced by an improved or corrected GDI.

The following steps are recommended towards improving the resolution of gender inequality in the *HDR*s. First, GDI's Equally Distributed Index formula should be changed, and several suggestions for doing so have been described in this chapter. Second, GDI should be supplemented by measures of gender inequality, and women's and men's level of development to give a more complete picture of human development. Finally, these new formulas should be reported in the *HDR* and evaluated both by academics and by development professionals for clarity and usefulness as tools for demonstrating the existence of, observing changes in, and finally disassembling systems of gender disparities in human development. The next chapter of this dissertation addresses both complements and alternatives to the current GDI, including modifications to improve its quality.

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Appendix A: Data

Appendix Table A: Data used in calculating GDI (2003)

HDI		Population Share		Life Expectancy		Literacy		Enrollment		Earned Income	
rank	Country	F	M	F	M	F	M	F	M	F	M
1	Norway	0.503	0.497	81.9	76.8	99.0	99.0	100	97	$32,272	$43,148
2	Australia	0.506	0.494	82.8	77.7	99.0	99.0	100	100	$24,827	$34,446
3	Iceland	0.500	0.500	82.6	78.7	99.0	99.0	100	91	$25,411	$36,908
4	Sweden	0.504	0.496	82.4	77.9	99.0	99.0	100	100	$21,842	$31,722
5	Canada	0.504	0.496	82.4	77.4	99.0	99.0	96	92	$23,922	$37,572
6	Switzerland	0.516	0.484	83.2	77.6	99.0	99.0	88	92	$28,972	$32,149
7	Luxembourg	0.507	0.493	81.5	75.2	99.0	99.0	89	88	$34,890	$40,000
8	United States	0.508	0.492	80.0	74.6	99.0	99.0	97	89	$29,017	$46,456
9	Belgium	0.509	0.491	82.0	75.7	99.0	99.0	100	100	$19,951	$37,019
10	Finland	0.510	0.490	81.7	75.1	99.0	99.0	100	100	$23,211	$32,250
11	Netherlands	0.504	0.496	81.1	75.7	99.0	99.0	99	99	$20,512	$38,389
12	Ireland	0.503	0.497	80.3	75.1	99.0	99.0	97	89	$22,125	$53,549
13	Denmark	0.505	0.495	79.4	74.8	99.0	99.0	100	97	$26,587	$36,430
14	Japan	0.512	0.488	85.4	78.4	99.0	99.0	83	85	$17,795	$38,612
15	United Kingdom	0.512	0.488	80.6	76.0	99.0	99.0	100	100	$20,790	$33,713
16	France	0.513	0.487	83.0	75.9	99.0	99.0	94	90	$20,642	$35,123
17	Italy	0.515	0.485	83.1	76.9	99.0	99.0	89	85	$17,176	$37,670
18	New Zealand	0.509	0.491	81.3	76.8	99.0	99.0	100	94	$18,379	$26,960
19	Austria	0.511	0.489	81.8	76.0	99.0	99.0	90	88	$15,878	$45,174
20	Germany	0.512	0.488	81.5	75.7	99.0	99.0	88	90	$19,534	$36,258
21	Spain	0.509	0.491	83.2	75.9	99.0	99.0	96	91	$13,854	$31,322
22	Israel	0.505	0.495	81.7	77.6	95.6	98.3	93	89	$14,159	$25,969
23	Hong Kong, China (SAR)	0.524	0.476	84.6	78.7	89.6	96.9	73	74	$19,593	$35,037
24	Greece	0.506	0.494	80.9	75.6	99.0	99.0	93	91	$12,531	$27,591
25	Slovenia	0.512	0.488	80.0	72.7	99.0	99.0	99	92	$14,751	$23,779
26	Portugal	0.517	0.483	80.6	73.9	99.0	99.0	97	90	$12,853	$23,829
27	Korea, Rep. of	0.499	0.501	80.6	73.3	99.0	99.0	87	100	$11,698	$24,167
28	Cyprus	0.514	0.486	81.1	76.1	95.1	98.6	79	78	$11,864	$25,260
29	Barbados	0.517	0.483	78.5	71.4	99.0	99.0	94	84	$11,976	$19,687
30	Czech Republic	0.513	0.487	78.7	72.3	99.0	99.0	81	80	$12,843	$20,051
31	Hungary	0.524	0.476	76.8	68.6	99.0	99.0	92	87	$11,287	$18,183
32	Malta	0.504	0.496	80.8	75.9	89.2	86.4	80	78	$9,893	$25,525
33	Poland	0.515	0.485	78.4	70.3	99.0	99.0	93	88	$8,769	$14,147
34	Argentina	0.511	0.489	78.2	70.7	97.2	97.2	99	91	$6,635	$17,800
35	Estonia	0.540	0.460	77.0	65.6	99.0	99.0	99	87	$10,745	$16,750
36	Lithuania	0.534	0.466	77.8	66.6	99.0	99.0	98	90	$9,595	$14,064
37	Slovakia	0.515	0.485	77.9	70.1	99.0	99.0	76	74	$10,681	$16,463
38	Chile	0.505	0.495	80.9	74.8	95.6	95.8	81	82	$5,753	$14,872
39	Kuwait	0.400	0.600	79.5	75.2	81.0	84.7	85	75	$8,448	$24,204
40	Croatia	0.519	0.481	78.4	71.4	97.1	99.0	76	74	$8,047	$14,351
41	Bahrain	0.430	0.570	75.9	73.1	83.0	92.5	85	77	$7,685	$24,909
42	Uruguay	0.515	0.485	79.0	71.7	98.1	97.3	93	83	$5,763	$10,950
43	Latvia	0.543	0.457	77.0	65.8	99.0	99.0	95	84	$8,050	$12,886
44	Costa Rica	0.492	0.508	80.6	75.9	95.9	95.7	69	67	$5,236	$14,000
45	Bulgaria	0.516	0.484	75.6	68.9	97.7	98.7	78	77	$6,212	$9,334
46	Mexico	0.511	0.489	77.5	72.6	88.7	92.0	76	74	$5,068	$13,506
47	Panama	0.496	0.504	77.4	72.3	91.2	92.5	82	76	$4,597	$9,069
48	Trinidad and Tobago	0.507	0.493	73.0	66.9	97.9	99.0	67	64	$6,792	$14,807
49	Macedonia, TFYR	0.501	0.499	76.3	71.3	94.1	98.2	71	69	$4,861	$8,725
50	Malaysia	0.492	0.508	75.6	70.9	85.4	92.0	73	68	$6,075	$12,869
51	Romania	0.513	0.487	75.0	67.8	96.3	98.4	73	70	$5,391	$9,261
52	Brazil	0.507	0.493	74.6	66.6	88.6	88.3	93	89	$4,704	$10,963
53	Belarus	0.533	0.467	74.0	62.4	99.0	99.0	91	86	$4,842	$7,418
54	Mauritius	0.504	0.496	75.7	68.8	80.5	88.2	71	71	$6,084	$16,606
55	Colombia	0.506	0.494	75.4	69.3	94.6	93.7	72	69	$4,557	$8,892
56	Albania	0.504	0.496	76.7	71.0	98.3	99.0	70	68	$3,266	$5,836
57	Thailand	0.509	0.491	73.8	66.3	90.5	94.9	72	72	$5,784	$9,452
58	Venezuela	0.498	0.502	75.9	70.0	92.7	93.3	76	73	$2,890	$6,929
59	Ukraine	0.541	0.459	72.5	60.1	99.0	99.0	87	84	$3,891	$7,329
60	Kazakhstan	0.521	0.479	69.0	57.8	99.0	99.0	87	83	$5,221	$8,217
61	Oman	0.438	0.562	75.7	72.8	65.4	82.0	63	63	$4,013	$21,614
62	Armenia	0.534	0.466	74.7	68.0	99.0	99.0	74	69	$3,026	$4,352
63	Philippines	0.497	0.503	72.5	68.3	92.7	92.5	83	80	$3,213	$5,409
64	China	0.486	0.514	73.5	69.9	86.5	95.1	68	70	$3,961	$5,976
65	Saudi Arabia	0.460	0.540	73.9	70.1	69.3	87.1	57	58	$4,440	$20,717
66	Sri Lanka	0.492	0.508	76.8	71.5	88.6	92.2	69	67	$2,579	$5,009
67	Peru	0.497	0.503	72.6	67.5	82.1	93.5	88	87	$2,231	$8,256
68	Lebanon	0.510	0.490	74.2	69.8	81.0	92.4	80	77	$2,430	$7,789
69	Tunisia	0.496	0.504	75.4	71.2	65.3	83.4	76	73	$3,840	$10,420
70	Fiji	0.492	0.508	70.1	65.7	91.4	94.5	73	73	$3,146	$8,525

Appendix Table A (continued): Data used in calculating GDI (2003)

HDI		Population Share		Life Expectancy		Literacy		Enrollment		Earned Income	
rank	Country	F	M	F	M	F	M	F	M	F	M
71	Turkey	0.496	0.504	71.1	66.5	81.1	95.7	62	74	$4,276	$9,286
72	Paraguay	0.496	0.504	73.2	68.7	90.2	93.1	74	73	$2,316	$7,000
73	Jordan	0.480	0.520	72.9	69.9	84.7	95.1	79	77	$2,004	$6,491
74	Dominican Republic	0.495	0.505	71.0	63.9	87.3	88.0	81	71	$3,608	$9,949
75	Jamaica	0.506	0.494	72.5	69.0	91.4	83.8	77	71	$3,279	$4,944
76	Belize	0.495	0.505	74.5	69.5	77.1	76.7	78	76	$2,695	$11,143
77	Azerbaijan	0.515	0.485	70.5	63.2	98.2	99.0	68	71	$2,683	$4,591
78	Iran, Islamic Rep. of	0.493	0.507	71.9	69.0	70.4	83.5	65	72	$3,094	$10,856
79	Guyana	0.515	0.485	66.1	60.0	98.2	99.0	78	77	$2,426	$6,152
80	El Salvador	0.508	0.492	73.9	67.8	77.1	82.4	67	68	$2,939	$6,689
81	Cape Verde	0.520	0.480	73.2	67.0	68.0	85.4	73	73	$3,392	$7,136
82	Algeria	0.496	0.504	72.4	69.8	60.1	79.5	72	76	$2,896	$9,244
83	Syrian Arab Republic	0.497	0.503	75.1	71.6	74.2	91.0	60	65	$1,584	$5,534
84	Viet Nam	0.501	0.499	72.6	68.6	86.9	93.9	61	67	$2,026	$2,964
85	Kyrgyzstan	0.508	0.492	71.1	62.7	98.1	99.0	83	81	$1,388	$2,128
86	Uzbekistan	0.503	0.497	69.8	63.4	98.9	99.6	74	77	$1,385	$2,099
87	Indonesia	0.501	0.499	68.8	64.9	83.4	92.5	65	67	$2,289	$4,434
88	Nicaragua	0.500	0.500	72.1	67.3	76.6	76.8	71	68	$2,018	$4,512
89	Bolivia	0.502	0.498	66.2	62.0	80.4	92.9	84	90	$1,615	$3,573
90	Mongolia	0.499	0.501	66.1	62.1	97.5	98.0	80	69	$1,478	$2,227
91	Moldova, Rep. of	0.522	0.478	71.3	63.9	95.0	97.5	64	60	$1,200	$1,850
92	South Africa	0.509	0.491	50.2	46.8	80.9	84.1	78	78	$6,505	$14,326
93	Tajikistan	0.504	0.496	66.3	61.0	99.0	99.0	69	82	$854	$1,367
94	Guatemala	0.513	0.487	71.0	63.6	63.3	75.4	59	63	$2,073	$6,197
95	Equatorial Guinea	0.505	0.495	43.9	42.6	76.4	92.1	60	71	$10,771	$27,053
96	Namibia	0.504	0.496	49.0	47.6	83.5	86.8	72	70	$4,201	$8,234
97	Morocco	0.503	0.497	71.9	67.5	38.3	63.3	54	62	$2,299	$5,699
98	India	0.487	0.513	65.0	61.8	47.8	73.4	56	64	$1,569	$4,130
99	Cambodia	0.517	0.483	59.8	52.4	64.1	84.7	54	64	$1,807	$2,368
100	Botswana	0.509	0.491	36.7	35.9	81.5	76.1	71	70	$6,617	$10,816
101	Comoros	0.498	0.502	65.4	61.1	49.1	63.5	42	51	$1,216	$2,206
102	Lao People's Dem. Rep.	0.500	0.500	55.9	53.4	60.9	77.0	55	67	$1,391	$2,129
103	Papua New Guinea	0.484	0.516	56.0	54.9	50.9	63.4	37	44	$1,896	$3,305
104	Ghana	0.494	0.506	57.3	56.3	45.7	62.9	43	48	$1,915	$2,567
105	Bangladesh	0.489	0.511	63.7	62.1	31.4	50.3	54	52	$1,245	$2,289
106	Nepal	0.505	0.495	62.0	61.2	34.9	62.7	55	66	$949	$1,868
107	Pakistan	0.485	0.515	63.2	62.8	35.2	61.7	31	43	$1,050	$3,082
108	Congo	0.504	0.496	53.2	50.7	77.1	88.9	44	52	$689	$1,238
109	Uganda	0.500	0.500	47.6	46.9	59.2	78.8	72	75	$1,169	$1,751
110	Sudan	0.497	0.503	57.9	54.9	49.9	69.2	35	41	$918	$2,890
111	Zimbabwe	0.504	0.496	36.5	37.3	86.3	93.8	51	54	$1,751	$3,042
112	Togo	0.506	0.494	56.3	52.4	38.3	68.5	52	76	$1,092	$2,318
113	Cameroon	0.503	0.497	46.5	45.1	59.8	77.0	50	60	$1,310	$2,940
114	Lesotho	0.535	0.465	37.7	34.6	90.3	73.7	67	65	$1,480	$3,759
115	Swaziland	0.518	0.482	32.9	32.1	78.1	80.4	58	61	$2,669	$6,927
116	Madagascar	0.503	0.497	56.8	54.1	65.2	76.4	40	41	$603	$1,017
117	Kenya	0.499	0.501	46.3	48.1	70.2	77.7	50	53	$1,001	$1,078
118	Mauritania	0.506	0.494	54.3	51.1	43.4	59.5	43	47	$1,269	$2,284
119	Gambia	0.504	0.496	57.1	54.3	30.9	45.0	45	50	$1,391	$2,339
120	Senegal	0.508	0.492	56.9	54.5	29.2	51.1	37	43	$1,175	$2,131
121	Yemen	0.493	0.507	61.9	59.3	28.5	69.5	41	69	$413	$1,349
122	Rwanda	0.515	0.485	45.6	42.1	58.8	70.5	53	58	$985	$1,583
123	Nigeria	0.494	0.506	43.6	43.1	59.4	74.4	57	71	$614	$1,495
124	Angola	0.507	0.493	42.3	39.3	53.8	82.1	27	32	$1,797	$2,897
125	Eritrea	0.509	0.491	55.7	51.8	45.6	68.2	30	40	$579	$1,125
126	Benin	0.496	0.504	54.7	53.2	22.6	46.4	43	66	$910	$1,316
127	Tanzania, U. Rep. of	0.503	0.497	46.3	45.5	62.2	77.5	40	42	$516	$725
128	Côte d'Ivoire	0.492	0.508	46.7	45.2	38.2	60.1	34	50	$792	$2,142
129	Malawi	0.504	0.496	39.6	39.8	54.0	74.9	69	75	$486	$717
130	Zambia	0.499	0.501	36.9	37.9	59.7	76.1	45	50	$629	$1,130
131	Congo, Dem. Rep. of the	0.504	0.496	44.1	42.1	51.9	79.8	24	31	$500	$903
132	Burundi	0.512	0.488	44.5	42.6	51.9	66.8	31	40	$545	$758
133	Mozambique	0.516	0.484	42.7	41.1	31.4	62.3	38	48	$910	$1,341
134	Ethiopia	0.503	0.497	48.7	46.6	33.8	49.2	29	42	$487	$931
135	Guinea-Bissau	0.506	0.494	46.2	43.2	24.7	55.2	29	45	$466	$960
136	Mali	0.502	0.498	48.5	47.2	11.9	26.7	27	38	$742	$1,247
137	Chad	0.505	0.495	44.7	42.5	12.7	40.6	28	48	$902	$1,525
138	Burkina Faso	0.497	0.503	48.2	46.8	8.1	18.5	20	27	$986	$1,357
139	Sierra Leone	0.507	0.493	42.1	39.4	20.5	39.8	38	52	$325	$783
140	Niger	0.489	0.511	44.4	44.3	9.4	19.6	17	25	$601	$1,056

Sources: UNDP, HDR 2005 Table 25; UNDP, World Population Prospects: The 2004 Revision Population Database.

Appendix B: Replication

The component indices, penalties, and GDI values used throughout this chapter are taken from the author's best replication of GDI and not directly from *HDR 2005*. The use of a replication is necessary because the UNDP does not report component indices or penalty values. After comparing several replications, one stood out as the "best" replication because it most closely approximated the GDI values reported in *HDR 2005*. The following data and assumptions were used to calculate this replication:

- Since the *HDR 2005* does not report population shares by gender or cite the source of the population share data, projected female and male population shares for 2005 were taken from the UN's World Population Prospects: The 2004 Revision Population Database. While data for 2003 were available, the 2005 data resulted in a closer approximation of the UNDP's GDI values. (These data are reported in Appendix Table A.)

- It is assumed that the UNDP has assigned the Czech Republic male and female adult literacy rates of 99.0%. No male and female adult literacy rates are reported for the Czech Republic, and there is no indication in *HDR 2005* that a value of 99.0% will be assumed. The UNDP nonetheless, includes the Czech Republic in all of the *HDR 2005* GDI calculations.

- Combined gross school enrollment rates higher than 100 percent have been rounded down to 100 percent. There is no notation of this assumption in *HDR 2005*, but, based on footnotes to past years' GDIs and footnotes to the HDI in *HDR 2005* Table 1, it appears to be the UNDP's practice.

Appendix Table B: GDI best replication (2003)

UNDP's GDI rank	Replication rank	HDI rank	Country	EDH	EDE	EDY	UNDP's GDI	GDI replication	UNDP's GDI less replication
1	1	1	Norway	0.906	0.988	0.988	0.960	0.961	-0.001
2	2	3	Australia	0.921	0.993	0.947	0.954	0.954	0.000
3	3	2	Iceland	0.927	0.978	0.954	0.953	0.953	0.000
4	4	6	Sweden	0.919	0.993	0.929	0.947	0.947	0.000
5	5	5	Canada	0.915	0.973	0.950	0.946	0.946	0.000
6	6	7	Switzerland	0.923	0.960	0.954	0.946	0.946	0.000
7	7	4	Luxembourg	0.889	0.955	0.988	0.944	0.944	0.000
8	8	10	United States	0.872	0.970	0.983	0.942	0.942	0.000
9	9	9	Belgium	0.898	0.993	0.932	0.941	0.941	0.000
10	10	13	Finland	0.890	0.993	0.935	0.940	0.940	0.000
11	12	8	Ireland	0.878	0.970	0.969	0.939	0.939	0.000
12	11	12	Netherlands	0.890	0.990	0.938	0.939	0.939	0.000
13	13	14	Denmark	0.868	0.988	0.957	0.938	0.938	0.000
14	14	11	Japan	0.948	0.940	0.923	0.937	0.937	0.000
15	15	15	United Kingdom	0.888	0.993	0.928	0.937	0.937	0.000
16	16	16	France	0.908	0.967	0.931	0.935	0.935	0.000
17	18	19	New Zealand	0.901	0.983	0.900	0.929	0.928	0.001
18	17	18	Italy	0.917	0.950	0.918	0.928	0.928	0.000
19	19	17	Austria	0.898	0.957	0.923	0.926	0.926	0.000
20	20	20	Germany	0.893	0.957	0.928	0.926	0.926	0.000
21	21	21	Spain	0.909	0.972	0.885	0.922	0.922	0.000
22	23	22	Hong Kong, China (SAR)	0.944	0.865	0.925	0.912	0.911	0.001
23	22	23	Israel	0.911	0.950	0.874	0.911	0.911	0.000
24	24	24	Greece	0.888	0.967	0.866	0.907	0.907	0.000
25	25	25	Slovenia	0.856	0.978	0.871	0.901	0.902	-0.001
26	26	26	Portugal	0.871	0.972	0.857	0.900	0.900	0.000
27	27	27	Korea, Rep. of	0.865	0.971	0.851	0.896	0.896	0.000
28	28	28	Cyprus	0.893	0.907	0.854	0.884	0.885	-0.001
29	29	29	Barbados	0.833	0.957	0.837	0.876	0.875	0.001
30	30	30	Czech Republic	0.842	0.928	0.845	0.872	0.872	0.000
31	31	33	Hungary	0.795	0.959	0.825	0.860	0.860	0.000
32	32	31	Malta	0.889	0.849	0.838	0.858	0.859	-0.001
33	33	34	Poland	0.822	0.962	0.783	0.856	0.856	0.000
34	34	32	Argentina	0.824	0.965	0.772	0.854	0.854	0.000
35	35	36	Estonia	0.772	0.971	0.813	0.852	0.852	0.000
36	36	37	Lithuania	0.787	0.974	0.790	0.851	0.850	0.001
37	37	38	Slovakia	0.817	0.910	0.813	0.847	0.847	0.000
38	38	35	Chile	0.881	0.910	0.746	0.846	0.846	0.000
39	39	40	Kuwait	0.874	0.818	0.837	0.843	0.843	0.000
40	41	39	Bahrain	0.827	0.857	0.825	0.837	0.836	0.001
41	40	41	Croatia	0.832	0.904	0.776	0.837	0.837	0.000
42	42	42	Uruguay	0.839	0.945	0.725	0.836	0.836	0.000
43	43	44	Latvia	0.774	0.960	0.766	0.834	0.833	0.001
44	44	43	Costa Rica	0.888	0.865	0.735	0.829	0.829	0.000
45	45	46	Bulgaria	0.788	0.913	0.720	0.807	0.807	0.000
46	46	45	Mexico	0.834	0.852	0.726	0.804	0.804	0.000
47	47	47	Panama	0.831	0.876	0.691	0.800	0.799	0.001
48	48	48	Trinidad and Tobago	0.749	0.875	0.763	0.796	0.796	0.000
49	49	49	Macedonia, TFYR	0.813	0.874	0.694	0.794	0.794	0.000
50	50	50	Malaysia	0.804	0.826	0.744	0.791	0.791	0.000
51	51	52	Romania	0.773	0.887	0.707	0.789	0.789	0.000
52	52	51	Brazil	0.760	0.893	0.705	0.786	0.786	0.000
53	53	54	Belarus	0.719	0.955	0.679	0.785	0.785	0.000
54	54	53	Mauritius	0.787	0.798	0.760	0.781	0.782	-0.001
55	55	55	Colombia	0.789	0.863	0.688	0.780	0.780	0.000
56	56	57	Albania	0.814	0.888	0.626	0.776	0.776	0.000
57	57	58	Thailand	0.751	0.857	0.715	0.774	0.774	0.000
58	58	59	Venezuela	0.799	0.868	0.626	0.765	0.765	0.000
59	59	61	Ukraine	0.688	0.945	0.655	0.763	0.763	0.000
60	61	56	Oman	0.823	0.704	0.748	0.759	0.758	0.001
61	60	63	Kazakhstan	0.638	0.944	0.694	0.759	0.759	0.000
62	62	65	Armenia	0.773	0.899	0.596	0.756	0.756	0.000
63	63	66	Philippines	0.757	0.889	0.620	0.755	0.755	0.000
64	64	67	China	0.778	0.835	0.647	0.754	0.754	0.000
65	65	60	Saudi Arabia	0.784	0.713	0.750	0.749	0.749	0.000
66	66	73	Sri Lanka	0.819	0.829	0.594	0.747	0.747	0.000
67	67	62	Peru	0.751	0.876	0.609	0.745	0.745	0.000
68	68	64	Lebanon	0.783	0.838	0.613	0.745	0.745	0.000
69	69	69	Tunisia	0.805	0.740	0.683	0.743	0.743	0.000
70	72	68	Paraguay	0.766	0.856	0.604	0.742	0.742	0.000

Appendix Table B (continued): GDI best replication (2003)

UNDP's GDI rank	Replication rank	HDI rank	Country	EDH	EDE	EDY	UNDP's GDI	GDI replication	UNDP's GDI less replication
71	70	72	Fiji	0.715	0.863	0.650	0.742	0.743	-0.001
72	71	74	Turkey	0.730	0.811	0.686	0.742	0.742	0.000
73	73	70	Jordan	0.774	0.859	0.586	0.740	0.740	0.000
74	74	75	Dominican Republic	0.707	0.837	0.673	0.739	0.739	0.000
75	75	76	Jamaica	0.762	0.830	0.614	0.736	0.735	0.001
76	76	71	Belize	0.783	0.769	0.648	0.734	0.734	0.000
77	77	78	Azerbaijan	0.698	0.889	0.589	0.725	0.725	0.000
78	78	77	Iran, Islamic Rep. of	0.757	0.738	0.663	0.719	0.719	0.000
79	79	83	Guyana	0.634	0.916	0.598	0.716	0.716	0.000
80	80	80	El Salvador	0.764	0.756	0.624	0.715	0.715	0.000
81	81	81	Cape Verde	0.752	0.748	0.642	0.714	0.714	0.000
82	82	79	Algeria	0.768	0.705	0.645	0.706	0.706	0.000
83	83	82	Syrian Arab Republic	0.806	0.754	0.547	0.702	0.702	0.000
84	84	84	Viet Nam	0.760	0.815	0.532	0.702	0.702	0.000
85	85	85	Kyrgyzstan	0.698	0.930	0.471	0.700	0.700	0.000
86	86	87	Uzbekistan	0.693	0.913	0.471	0.692	0.692	0.000
87	87	86	Indonesia	0.697	0.805	0.572	0.691	0.692	-0.001
88	88	88	Nicaragua	0.745	0.743	0.561	0.683	0.683	0.000
89	89	89	Bolivia	0.652	0.864	0.522	0.679	0.679	0.000
90	90	90	Mongolia	0.652	0.900	0.481	0.677	0.678	-0.001
91	91	91	Moldova, Rep. of	0.710	0.848	0.446	0.668	0.668	0.000
92	92	93	South Africa	0.391	0.810	0.756	0.652	0.652	0.000
93	93	95	Tajikistan	0.644	0.911	0.393	0.650	0.649	0.001
94	94	92	Guatemala	0.705	0.661	0.581	0.649	0.649	0.000
95	95	94	Equatorial Guinea	0.301	0.773	0.850	0.641	0.641	0.000
96	96	97	Namibia	0.386	0.804	0.675	0.621	0.622	-0.001
97	97	96	Morocco	0.745	0.514	0.589	0.616	0.616	0.000
98	98	98	India	0.640	0.590	0.530	0.586	0.587	-0.001
99	99	99	Cambodia	0.518	0.679	0.504	0.567	0.567	0.000
100	100	100	Botswana	0.181	0.760	0.738	0.559	0.560	-0.001
101	101	101	Comoros	0.637	0.523	0.462	0.541	0.541	0.000
102	102	102	Lao People's Dem. Rep.	0.493	0.655	0.472	0.540	0.540	0.000
103	103	105	Papua New Guinea	0.506	0.512	0.535	0.518	0.518	0.000
104	104	106	Ghana	0.528	0.506	0.516	0.517	0.517	0.000
105	105	107	Bangladesh	0.631	0.442	0.467	0.514	0.514	0.000
106	106	104	Nepal	0.608	0.503	0.424	0.511	0.512	-0.001
107	107	103	Pakistan	0.632	0.423	0.468	0.508	0.508	0.000
108	108	109	Congo	0.448	0.709	0.364	0.507	0.507	0.000
109	109	111	Uganda	0.367	0.698	0.442	0.502	0.502	0.000
110	110	108	Sudan	0.523	0.514	0.447	0.495	0.494	0.001
111	111	112	Zimbabwe	0.186	0.774	0.519	0.493	0.493	0.000
112	112	110	Togo	0.489	0.533	0.453	0.491	0.491	0.000
113	113	115	Cameroon	0.344	0.630	0.487	0.487	0.487	0.000
114	114	116	Lesotho	0.183	0.766	0.511	0.487	0.487	0.000
115	115	114	Swaziland	0.114	0.726	0.615	0.485	0.485	0.000
116	116	113	Madagascar	0.507	0.604	0.338	0.483	0.483	0.000
117	117	119	Kenya	0.361	0.663	0.391	0.472	0.472	0.000
118	118	118	Mauritania	0.461	0.485	0.467	0.471	0.471	0.000
119	119	120	Gambia	0.511	0.403	0.478	0.464	0.464	0.000
120	120	121	Senegal	0.510	0.383	0.455	0.449	0.449	0.000
121	121	117	Yemen	0.593	0.446	0.308	0.448	0.449	-0.001
122	122	123	Rwanda	0.313	0.611	0.416	0.447	0.447	0.000
123	123	122	Nigeria	0.302	0.652	0.363	0.439	0.439	0.000
124	124	124	Angola	0.262	0.531	0.518	0.438	0.437	0.001
125	125	125	Eritrea	0.479	0.477	0.339	0.431	0.432	-0.001
126	126	126	Benin	0.481	0.379	0.397	0.419	0.419	0.000
127	127	128	Tanzania, U. Rep. of	0.345	0.597	0.299	0.414	0.414	0.000
128	128	127	Côte d'Ivoire	0.347	0.448	0.414	0.403	0.403	0.000
129	129	129	Malawi	0.237	0.660	0.293	0.396	0.396	0.000
130	130	130	Zambia	0.195	0.605	0.349	0.383	0.383	0.000
131	131	131	Congo, Dem. Rep. of the	0.299	0.509	0.310	0.373	0.373	0.000
132	132	133	Burundi	0.306	0.504	0.307	0.373	0.373	0.000
133	133	132	Mozambique	0.278	0.421	0.397	0.365	0.365	0.000
134	134	134	Ethiopia	0.376	0.381	0.309	0.355	0.355	0.000
135	135	135	Guinea-Bissau	0.327	0.346	0.305	0.326	0.326	0.000
136	136	137	Mali	0.378	0.217	0.373	0.323	0.323	0.000
137	137	136	Chad	0.308	0.251	0.406	0.322	0.322	0.000
138	138	138	Burkina Faso	0.373	0.154	0.407	0.311	0.311	0.000
139	139	139	Sierra Leone	0.261	0.328	0.249	0.279	0.279	0.000
140	140	140	Niger	0.318	0.154	0.341	0.271	0.271	0.000

Source: HDR 2005, and author's calculations using HDR 2005 data.

Appendix C: Hidden Penalty

The impact of the order of operations is demonstrated in Tables C1 and C2. In Table C1, first a weighted average of log female and male income is taken; this is the order of calculations in Weighted HDI (Column 5):

$$(20)\ A = [FemalePopShare * \ln(Female\text{-}Y)] + [MalePopShare * \ln(Male\text{-}Y)]$$

Then a log is taken of the weighted average of the female and male incomes; this is the order of calculations in HDI (Column 6):

$$(21)\ B = \ln[(FemalePopShare * Female\text{-}Y) + (MalePopShare * Male\text{-}Y)]$$

As long as female and male incomes are not equal, different orders of operation achieve different results.

Table C1: Demonstration of impact of the order of calculations for income

Female Share	Male Share	Female Value	Male Value	Weighted Average of Log Value (A)	Log Value of Weighted Average (B)	Difference
0.50	0.50	$100	$100	4.61	4.61	0.00
0.50	0.50	$100	$200	4.95	5.01	-0.06
0.50	0.50	$100	$1,000	5.76	6.31	-0.55
0.50	0.50	$100	$10,000	6.91	8.53	-1.62
0.45	0.55	$100	$100	4.61	4.61	0.00
0.45	0.55	$100	$200	4.99	5.04	-0.06
0.45	0.55	$100	$1,000	5.87	6.39	-0.52
0.45	0.55	$100	$10,000	7.14	8.62	-1.48
0.55	0.45	$100	$100	4.61	4.61	0.00
0.55	0.45	$100	$200	4.92	4.98	-0.06
0.55	0.45	$100	$1,000	5.64	6.22	-0.58
0.55	0.45	$100	$10,000	6.68	8.42	-1.75

Source: Author's calculations.

In the health and education components, HDI's first weighted average then normalization order of operations returns a much more similar result to Weighted-HDI's normalization then average; but taking a log at a different stage of the calculation, as occurs in the income component, makes a much larger difference. For EDH, as long as female and male population shares are equal, then the order of operations is irrelevant. If the female population share is less than the male, there is a bonus to the Weighted-HDI on the order of one-tenth of one percent as compared to HDI, but if the female population share is greater, there is a penalty to Weighted-HDI on the same order of magnitude. For EDE, regardless of balance of the population shares, there is a somewhat larger penalty to Weighted-HDI, on the order of magnitude of one to ten percent of HDI. Table C2 demonstrates these results.

Table C2: Demonstration of impact of the order of calculations in health and education

	Female Share	Male Share	Female Value	Male Value	Weighted Average of Normalized Index	Normalization of Weighted Average	Difference
Health	0.50	0.50	50	50	0.417	0.417	0.000
	0.50	0.50	60	50	0.500	0.500	0.000
	0.50	0.50	80	50	0.667	0.667	0.000
	0.50	0.50	40	50	0.333	0.333	0.000
	0.48	0.52	50	50	0.418	0.417	0.002
	0.48	0.52	60	50	0.498	0.497	0.002
	0.48	0.52	80	50	0.658	0.657	0.002
	0.48	0.52	40	50	0.338	0.337	0.002
	0.52	0.48	50	50	0.415	0.417	-0.002
	0.52	0.48	60	50	0.502	0.503	-0.002
	0.52	0.48	80	50	0.675	0.677	-0.002
	0.52	0.48	40	50	0.328	0.330	-0.002
Education	0.50	0.50	70	70	0.700	0.750	-0.050
	0.50	0.50	70	90	0.800	0.917	-0.117
	0.50	0.50	70	100	0.850	1.000	-0.150
	0.50	0.50	70	60	0.650	0.667	-0.017
	0.48	0.52	70	70	0.700	0.750	-0.050
	0.48	0.52	70	90	0.804	0.923	-0.119
	0.48	0.52	70	100	0.856	1.010	-0.154
	0.48	0.52	70	60	0.648	0.663	-0.015
	0.52	0.48	70	70	0.700	0.750	-0.050
	0.52	0.48	70	90	0.796	0.910	-0.114
	0.52	0.48	70	100	0.844	0.990	-0.146
	0.52	0.48	70	60	0.652	0.670	-0.018

Source: Author's calculations.

Appendix D: Valuing Gender Equality

Table D: Rankings of GDIs with higher penalty factors (2003)

Rank	Weighted HDI	GDI	GDI ε = 10	GDI ε = 100
1	Norway	Norway	Norway	Norway
2	Australia	Australia	Australia	Australia
3	Iceland	Iceland	Iceland	Switzerland
4	Sweden	Sweden	Sweden	Iceland
5	Canada	Canada	Switzerland	Luxembourg
6	Switzerland	Switzerland	Canada	Sweden
7	Luxembourg	Luxembourg	Luxembourg	Canada
8	U.S.	U.S.	U.S.	Denmark
9	Belgium	Belgium	Finland	Finland
10	Ireland	Finland	Belgium	U.S.
11	Netherlands	Netherlands	Denmark	U.K.
12	Finland	Ireland	Netherlands	Belgium
13	Japan	Denmark	U.K.	Netherlands
14	Denmark	Japan	Ireland	France
15	U.K.	U.K.	France	N.Zealand
16	France	France	Japan	Ireland
17	Italy	Italy	N.Zealand	Japan
18	Austria	N.Zealand	Italy	Germany
19	N.Zealand	Austria	Germany	Italy
20	Germany	Germany	Austria	Austria
21	Spain	Spain	Spain	Spain
22	Israel	Israel	Israel	Israel
23	Hong Kong	Hong Kong	Hong Kong	Hong Kong
24	Greece	Greece	Greece	Greece
25	Slovenia	Slovenia	Slovenia	Slovenia
26	Portugal	Portugal	Portugal	Portugal
27	S.Korea	S.Korea	S.Korea	S.Korea
28	Cyprus	Cyprus	Cyprus	Cyprus
29	Barbados	Barbados	Barbados	Czech Rep.
30	Czech Rep.	Czech Rep.	Czech Rep.	Barbados
31	Malta	Hungary	Hungary	Hungary
32	Hungary	Malta	Poland	Poland
33	Poland	Poland	Malta	Malta
34	Argentina	Argentina	Estonia	Slovakia
35	Estonia	Estonia	Lithuania	Lithuania
36	Lithuania	Lithuania	Slovakia	Argentina
37	Chile	Slovakia	Argentina	Chile
38	Slovakia	Chile	Chile	Estonia
39	Kuwait	Kuwait	Croatia	Croatia
40	Bahrain	Croatia	Kuwait	Uruguay
41	Croatia	Bahrain	Uruguay	Kuwait
42	Uruguay	Uruguay	Latvia	Costa Rica
43	Latvia	Latvia	Bahrain	Latvia
44	Costa Rica	Costa Rica	Costa Rica	Bahrain
45	Bulgaria	Bulgaria	Bulgaria	Bulgaria
46	Mexico	Mexico	Mexico	Panama
47	Panama	Panama	Panama	Mexico
48	Trin. & Tob.	Trin. & Tob.	Macedonia	Macedonia
49	Macedonia	Macedonia	Trin. & Tob.	Trin. & Tob.
50	Malaysia	Malaysia	Romania	Romania
51	Romania	Romania	Malaysia	Malaysia
52	Brazil	Brazil	Belarus	Colombia
53	Belarus	Belarus	Brazil	Albania
54	Mauritius	Mauritius	Colombia	Brazil
55	Colombia	Colombia	Albania	Belarus
56	Albania	Albania	Thailand	Thailand
57	Thailand	Thailand	Mauritius	Mauritius
58	Oman	Venezuela	Venezuela	Armenia
59	Venezuela	Ukraine	Armenia	Venezuela
60	Ukraine	Kazakhstan	Ukraine	Philippines
61	Kazakhstan	Oman	Philippines	China
62	Saudi Arabia	Armenia	Kazakhstan	Kazakhstan
63	Armenia	Philippines	China	Sri Lanka
64	Philippines	China	Sri Lanka	Ukraine
65	China	Saudi Arabia	Fiji	Fiji
66	Peru	Sri Lanka	Jamaica	Paraguay
67	Lebanon	Peru	Lebanon	Jamaica
68	Sri Lanka	Lebanon	Turkey	Lebanon
69	Tunisia	Tunisia	Paraguay	Dominican R.
70	Paraguay	Fiji	Dominican R.	Azerbaijan
71	Turkey	Turkey	Oman	Peru
72	Fiji	Paraguay	Tunisia	Turkey
73	Jordan	Jordan	Peru	Tunisia
74	Dominican R.	Dominican R.	Jordan	Belize
75	Belize	Jamaica	Saudi Arabia	Jordan
76	Jamaica	Belize	Azerbaijan	Oman
77	Azerbaijan	Azerbaijan	Belize	Guyana
78	Iran	Iran	El Salvador	Saudi Arabia
79	Guyana	Guyana	Guyana	El Salvador
80	El Salvador	El Salvador	Cape Verde	Viet Nam
81	Cape Verde	Cape Verde	Iran	Kyrgyzstan
82	Algeria	Algeria	Viet Nam	Cape Verde
83	Syria	Syria	Kyrgyzstan	Uzbekistan
84	Viet Nam	Viet Nam	Uzbekistan	Iran
85	Kyrgyzstan	Kyrgyzstan	Indonesia	Indonesia
86	Indonesia	Uzbekistan	Algeria	Nicaragua
87	Uzbekistan	Indonesia	Syria	Mongolia
88	Nicaragua	Nicaragua	Nicaragua	Algeria
89	Bolivia	Bolivia	Mongolia	Syria
90	Mongolia	Mongolia	Bolivia	Moldova
91	Moldova	Moldova	Moldova	Bolivia
92	Guatemala	South Africa	South Africa	Tajikistan
93	South Africa	Tajikistan	Tajikistan	South Africa
94	Tajikistan	Guatemala	Guatemala	Guatemala
95	Eq. Guinea	Eq. Guinea	Eq. Guinea	Namibia
96	Morocco	Namibia	Namibia	Eq. Guinea
97	Namibia	Morocco	Morocco	Morocco
98	India	India	India	Botswana
99	Cambodia	Cambodia	Cambodia	India
100	Botswana	Botswana	Botswana	Cambodia
101	Comoros	Comoros	Laos	Comoros
102	Laos	Laos	Comoros	Laos
103	Pakistan	Papua N.G.	Papua N.G.	Ghana
104	Nepal	Ghana	Ghana	Papua N.G.
105	Papua N.G.	Bangladesh	Bangladesh	Bangladesh
106	Ghana	Nepal	Congo	Congo
107	Bangladesh	Pakistan	Uganda	Uganda
108	Congo	Congo	Nepal	Zimbabwe
109	Uganda	Uganda	Zimbabwe	Nepal
110	Togo	Sudan	Madagascar	Madagascar
111	Sudan	Zimbabwe	Pakistan	Swaziland
112	Zimbabwe	Togo	Lesotho	Kenya
113	Cameroon	Cameroon	Swaziland	Lesotho
114	Lesotho	Lesotho	Sudan	Sudan
115	Swaziland	Swaziland	Cameroon	Pakistan
116	Madagascar	Madagascar	Kenya	Cameroon
117	Yemen	Kenya	Togo	Togo
118	Mauritania	Mauritania	Mauritania	Mauritania
119	Kenya	Gambia	Gambia	Gambia
120	Gambia	Senegal	Rwanda	Rwanda
121	Senegal	Yemen	Senegal	Senegal
122	Rwanda	Rwanda	Angola	Angola
123	Nigeria	Nigeria	Nigeria	Eritrea
124	Angola	Angola	Eritrea	Nigeria
125	Eritrea	Eritrea	Tanzania	Yemen
126	Benin	Benin	Yemen	Tanzania
127	Tanzania	Tanzania	Benin	Benin
128	Côte d'Ivoire	Côte d'Ivoire	Malawi	Malawi
129	Malawi	Malawi	Côte d'Ivoire	Côte d'Ivoire
130	Zambia	Zambia	Zambia	Burundi
131	Congo, D.R.	Congo, D.R.	Burundi	Zambia
132	Mozambique	Burundi	Congo, D.R.	Congo, D.R.
133	Burundi	Mozambique	Mozambique	Mozambique
134	Ethiopia	Ethiopia	Ethiopia	Ethiopia
135	Guinea-Bissau	Guinea-Bissau	Mali	Mali
136	Chad	Mali	Burkina Faso	Burkina Faso
137	Mali	Chad	Chad	Chad
138	Burkina Faso	Burkina Faso	Guinea-Bissau	Guinea-Bissau
139	Sierra Leone	Sierra Leone	Niger	Sierra Leone
140	Niger	Niger	Sierra Leone	Niger

Source: Author's calculations using HDR 2005 data.

Appendix E: Regarding the Direction of Penalties

Table E: Female versus male component indices and HDIs for selected countries (2003)

		H Index			E Index			Y Index			HDI		
GDI rank	Country	Female	Male	Gap	Female	Male	Gap	Female	Male	Gap	Female	Male	Gap
1	Norway	0.907	0.905	0.002	0.993	0.983	0.010	0.964	1.013	-0.048	0.955	0.967	-0.012
2	Australia	0.922	0.920	0.002	0.993	0.993	0.000	0.920	0.975	-0.055	0.945	0.963	-0.018
3	Iceland	0.918	0.937	-0.018	0.993	0.963	0.030	0.924	0.987	-0.062	0.945	0.962	-0.017
4	Sweden	0.915	0.923	-0.008	0.993	0.993	0.000	0.899	0.961	-0.062	0.936	0.959	-0.024
5	Canada	0.915	0.915	0.000	0.980	0.967	0.013	0.914	0.990	-0.075	0.936	0.957	-0.021
6	Switzerland	0.928	0.918	0.010	0.953	0.967	-0.013	0.946	0.964	-0.017	0.943	0.950	-0.007
7	Luxembourg	0.900	0.878	0.022	0.957	0.953	0.003	0.977	1.000	-0.023	0.945	0.944	0.001
8	United States	0.875	0.868	0.007	0.983	0.957	0.027	0.946	1.025	-0.079	0.935	0.950	-0.015
9	Belgium	0.908	0.887	0.022	0.993	0.993	0.000	0.884	0.987	-0.103	0.929	0.956	-0.027
10	Finland	0.903	0.877	0.027	0.993	0.993	0.000	0.909	0.964	-0.055	0.935	0.945	-0.009
11	Netherlands	0.893	0.887	0.007	0.990	0.990	0.000	0.889	0.993	-0.105	0.924	0.957	-0.033
12	Ireland	0.880	0.877	0.003	0.983	0.957	0.027	0.901	1.049	-0.148	0.921	0.961	-0.039
13	Denmark	0.865	0.872	-0.007	0.993	0.983	0.010	0.932	0.984	-0.053	0.930	0.946	-0.016
14	Japan	0.965	0.932	0.033	0.937	0.943	-0.007	0.865	0.994	-0.129	0.922	0.956	-0.034
15	United Kingdom	0.885	0.892	-0.007	0.993	0.993	0.000	0.891	0.971	-0.081	0.923	0.952	-0.029
16	France	0.925	0.890	0.035	0.973	0.960	0.013	0.890	0.978	-0.089	0.929	0.943	-0.013
17	Italy	0.927	0.907	0.020	0.957	0.943	0.013	0.859	0.990	-0.131	0.914	0.947	-0.033
18	New Zealand	0.897	0.905	-0.008	0.993	0.973	0.020	0.870	0.934	-0.064	0.920	0.937	-0.017
19	Austria	0.905	0.892	0.013	0.960	0.953	0.007	0.846	1.020	-0.175	0.904	0.955	-0.052
20	Germany	0.900	0.887	0.013	0.953	0.960	-0.007	0.880	0.984	-0.103	0.911	0.943	-0.032
21	Spain	0.928	0.890	0.038	0.980	0.963	0.017	0.823	0.959	-0.136	0.910	0.938	-0.027
23	Hong Kong, China (SAR)	0.952	0.937	0.015	0.841	0.893	-0.052	0.881	0.978	-0.097	0.891	0.936	-0.045
24	Greece	0.890	0.885	0.005	0.970	0.963	0.007	0.806	0.938	-0.132	0.889	0.929	-0.040
25	Slovenia	0.875	0.837	0.038	0.990	0.967	0.023	0.834	0.913	-0.080	0.900	0.906	-0.006
26	Portugal	0.885	0.857	0.028	0.983	0.960	0.023	0.811	0.914	-0.103	0.893	0.910	-0.017
27	Korea, Rep. of	0.885	0.847	0.038	0.950	0.993	-0.043	0.795	0.916	-0.121	0.877	0.919	-0.042
28	Cyprus	0.893	0.893	0.000	0.897	0.917	-0.020	0.797	0.923	-0.126	0.863	0.911	-0.049
29	Barbados	0.850	0.815	0.035	0.973	0.940	0.033	0.799	0.882	-0.083	0.874	0.879	-0.005
30	Czech Republic	0.853	0.830	0.023	0.930	0.927	0.003	0.810	0.885	-0.074	0.865	0.880	-0.016
31	Hungary	0.822	0.768	0.053	0.967	0.950	0.017	0.789	0.868	-0.080	0.859	0.862	-0.003
32	Malta	0.888	0.890	-0.002	0.861	0.836	0.025	0.767	0.925	-0.158	0.839	0.884	-0.045
33	Poland	0.848	0.797	0.052	0.970	0.953	0.017	0.747	0.827	-0.080	0.855	0.859	-0.004
34	Argentina	0.845	0.803	0.042	0.978	0.951	0.027	0.700	0.865	-0.165	0.841	0.873	-0.032
35	Estonia	0.825	0.718	0.107	0.990	0.950	0.040	0.781	0.855	-0.074	0.865	0.841	0.024
36	Lithuania	0.838	0.735	0.103	0.987	0.960	0.027	0.762	0.826	-0.064	0.862	0.840	0.022
37	Slovakia	0.840	0.793	0.047	0.913	0.907	0.007	0.780	0.852	-0.072	0.844	0.851	-0.006
38	Chile	0.890	0.872	0.018	0.907	0.912	-0.005	0.676	0.835	-0.159	0.825	0.873	-0.048
39	Kuwait	0.867	0.878	-0.012	0.823	0.815	0.009	0.740	0.916	-0.176	0.810	0.870	-0.060
40	Croatia	0.848	0.815	0.033	0.901	0.907	-0.006	0.732	0.829	-0.097	0.827	0.850	-0.023
42	Uruguay	0.858	0.820	0.038	0.964	0.925	0.039	0.677	0.784	-0.107	0.833	0.843	-0.010
43	Latvia	0.825	0.722	0.103	0.977	0.940	0.037	0.732	0.811	-0.079	0.845	0.824	0.020
44	Costa Rica	0.885	0.890	-0.005	0.869	0.861	0.008	0.661	0.825	-0.164	0.805	0.859	-0.054
45	Bulgaria	0.802	0.773	0.028	0.911	0.915	-0.003	0.689	0.757	-0.068	0.801	0.815	-0.014
47	Panama	0.832	0.830	0.002	0.881	0.870	0.011	0.639	0.752	-0.113	0.784	0.817	-0.033
48	Trinidad and Tobago	0.758	0.740	0.018	0.876	0.873	0.003	0.704	0.834	-0.130	0.779	0.816	-0.036
49	Macedonia, TFYR	0.813	0.813	0.000	0.864	0.885	-0.021	0.648	0.746	-0.098	0.775	0.815	-0.039
51	Romania	0.792	0.755	0.037	0.885	0.889	-0.004	0.665	0.756	-0.090	0.781	0.800	-0.019
52	Brazil	0.785	0.735	0.050	0.901	0.885	0.015	0.643	0.784	-0.141	0.776	0.801	-0.025
53	Belarus	0.775	0.665	0.110	0.963	0.947	0.017	0.648	0.719	-0.071	0.795	0.777	0.018
54	Mauritius	0.803	0.772	0.032	0.773	0.825	-0.051	0.686	0.853	-0.168	0.754	0.817	-0.062
55	Colombia	0.798	0.780	0.018	0.871	0.855	0.016	0.637	0.749	-0.112	0.769	0.795	-0.026
56	Albania	0.820	0.808	0.012	0.889	0.887	0.002	0.582	0.679	-0.097	0.764	0.791	-0.028
57	Thailand	0.772	0.730	0.042	0.843	0.873	-0.029	0.677	0.759	-0.082	0.764	0.787	-0.023
58	Venezuela	0.807	0.792	0.015	0.871	0.865	0.006	0.561	0.707	-0.146	0.746	0.788	-0.042
59	Ukraine	0.750	0.627	0.123	0.950	0.940	0.010	0.611	0.717	-0.106	0.770	0.761	0.009
60	Kazakhstan	0.692	0.588	0.103	0.950	0.937	0.013	0.660	0.736	-0.076	0.767	0.754	0.014
62	Armenia	0.787	0.758	0.028	0.907	0.890	0.017	0.569	0.630	-0.061	0.754	0.759	-0.005
63	Philippines	0.750	0.763	-0.013	0.895	0.883	0.011	0.579	0.666	-0.087	0.741	0.771	-0.030
66	Sri Lanka	0.822	0.817	0.005	0.821	0.838	-0.017	0.542	0.653	-0.111	0.728	0.769	-0.041
67	Peru	0.752	0.750	0.002	0.841	0.913	-0.073	0.518	0.737	-0.218	0.704	0.800	-0.096
74	Dominican Republic	0.725	0.690	0.035	0.852	0.823	0.029	0.598	0.768	-0.169	0.725	0.760	-0.035
75	Jamaica	0.750	0.775	-0.025	0.866	0.795	0.071	0.583	0.651	-0.069	0.733	0.740	-0.008
76	Belize	0.783	0.783	0.000	0.774	0.765	0.009	0.550	0.787	-0.237	0.702	0.778	-0.076
77	Azerbaijan	0.717	0.678	0.038	0.881	0.897	-0.015	0.549	0.639	-0.090	0.716	0.738	-0.022
79	Guyana	0.643	0.625	0.018	0.915	0.917	-0.002	0.532	0.688	-0.155	0.697	0.743	-0.046
80	El Salvador	0.773	0.755	0.018	0.737	0.776	-0.039	0.564	0.702	-0.137	0.692	0.744	-0.053
81	Cape Verde	0.762	0.742	0.020	0.697	0.813	-0.116	0.588	0.712	-0.124	0.682	0.756	-0.073
85	Kyrgyzstan	0.727	0.670	0.057	0.931	0.930	0.001	0.439	0.510	-0.071	0.699	0.703	-0.005
86	Uzbekistan	0.705	0.682	0.023	0.906	0.921	-0.015	0.439	0.508	-0.069	0.683	0.703	-0.020
88	Nicaragua	0.743	0.747	-0.003	0.747	0.739	0.009	0.501	0.636	-0.134	0.664	0.707	-0.043
90	Mongolia	0.643	0.660	-0.017	0.917	0.883	0.033	0.450	0.518	-0.068	0.670	0.687	-0.017
91	Moldova, Rep. of	0.730	0.690	0.040	0.847	0.850	-0.003	0.415	0.487	-0.072	0.664	0.676	-0.012
93	Tajikistan	0.647	0.642	0.005	0.890	0.933	-0.043	0.358	0.436	-0.079	0.632	0.670	-0.039
94	Guatemala	0.725	0.685	0.040	0.619	0.713	-0.094	0.506	0.689	-0.183	0.617	0.695	-0.079
99	Cambodia	0.538	0.498	0.040	0.607	0.778	-0.171	0.483	0.528	-0.045	0.543	0.602	-0.059
100	Botswana	0.153	0.223	-0.070	0.780	0.741	0.039	0.700	0.782	-0.082	0.544	0.582	-0.038
114	Lesotho	0.170	0.202	-0.032	0.825	0.708	0.117	0.450	0.605	-0.156	0.482	0.505	-0.023

Source: Author's calculations using HDR 2005 data; shading indicates female greater than male indices.

Appendix F: Rewarding Gender Mortality Bias

Each section of rows in Table F illustrates how the component index value for a given country changes when different gender population shares are applied. (The shaded row in each section indicates the country's actual population shares.) The range of female population shares in Table F (0.550 to 0.400) approximates the actual range among the countries for which GDI calculations are reported in *HDR 2005*.

For Belgium's income component, the penalty (or difference between using $\varepsilon = 0$ and $\varepsilon = 2$) stays the same when the population shares are varied, but the value of EDY ($\varepsilon = 2$) increases as the female population share shrinks – the less women living in Belgium, the higher the EDY. Similarly, for Estonia's life expectancy component – where, in contrast to Belgium's income component, the female index is larger than the male index – the penalty again stays the same and the EDH decreases as the female population share declines. For Algeria's income component – where the gap between the female and male indices is twice the size of those in the previous two examples – the same type of results holds. Finally, in extreme cases like Yemen's education component, where the gap between female and male indices is at its largest, as female population share decreases, not only does the EDY increase, but the size of the penalty itself also increases.

Table F: Demonstration of gender mortality bias in GDI (2003)

	Population Shares		Gendered Index		ED Index		
	Female	Male	Female	Male	ε = 0	ε = 2	Penalty
Belgium Income	0.550	0.450	0.884	0.987	0.930	0.928	0.003
	0.509	0.491	0.884	0.987	0.935	0.932	0.003
	0.505	0.495	0.884	0.987	0.935	0.932	0.003
	0.500	0.500	0.884	0.987	0.936	0.933	0.003
	0.450	0.550	0.884	0.987	0.941	0.938	0.003
	0.400	0.600	0.884	0.987	0.946	0.943	0.003
Estonia Health	0.550	0.450	0.825	0.718	0.777	0.773	0.004
	0.540	0.460	0.825	0.718	0.776	0.772	0.004
	0.505	0.495	0.825	0.718	0.772	0.768	0.004
	0.500	0.500	0.825	0.718	0.772	0.768	0.004
	0.450	0.550	0.825	0.718	0.766	0.763	0.004
	0.400	0.600	0.825	0.718	0.761	0.757	0.004
Algeria Income	0.550	0.450	0.562	0.756	0.649	0.635	0.014
	0.505	0.495	0.562	0.756	0.658	0.643	0.014
	0.500	0.500	0.562	0.756	0.659	0.644	0.014
	0.496	0.504	0.562	0.756	0.660	0.645	0.014
	0.450	0.550	0.562	0.756	0.668	0.654	0.014
	0.400	0.600	0.562	0.756	0.678	0.664	0.014
Yemen Education	0.550	0.450	0.327	0.693	0.492	0.429	0.063
	0.505	0.495	0.327	0.693	0.508	0.443	0.066
	0.500	0.500	0.327	0.693	0.510	0.444	0.066
	0.493	0.507	0.327	0.693	0.513	0.446	0.066
	0.450	0.550	0.327	0.693	0.528	0.461	0.068
	0.400	0.600	0.327	0.693	0.547	0.478	0.068

Source: Author's calculations using HDR 2005 data.