

1. Computing the human development index

The HDI is based on three indicators: longevity, as measured by life expectancy at birth; educational attainment, as measured by a combination of adult literacy (two-thirds weight) and combined primary, secondary and tertiary enrolment ratios (one-third weight); and standard of living, as measured by real GDP per capita (PPP\$).

For the construction of the index, fixed minimum and maximum values have been established for each of these indicators:

- Life expectancy at birth: 25 years and 85 years
- Adult literacy: 0% and 100%
- Combined enrolment ratio: 0% and 100%
- Real GDP per capita (PPP\$): PPP\$100 and PPP\$40,000.

For any component of the HDI, individual indices can be computed according to the general formula:

$$\text{Index} = \frac{\text{Actual } x_i \text{ value} - \text{minimum } x_i \text{ value}}{\text{Maximum } x_i \text{ value} - \text{minimum } x_i \text{ value}}$$

If, for example, the life expectancy at birth in a country is 65 years, the index of life expectancy for this country would be:

$$\text{Life expectancy index} = \frac{65 - 25}{85 - 25} = \frac{40}{60} = 0.667$$

The construction of the income index is a little more complex. The average world income of PPP\$5,711 is taken as the threshold level (y^*), and any income above this level is discounted using the following formulation based on Atkinson's formula for the utility of income:

$$\begin{aligned} W(y) &= y^* \text{ for } 0 < y < y^* \\ &= y^* + 2[(y - y^*)^{1/2}] \text{ for } y^* \leq y \leq 2y^* \\ &= y^* + 2(y^{*1/2}) + 3[(y - 2y^*)^{1/3}] \text{ for } 2y^* \leq y \leq 3y^* \end{aligned}$$

To calculate the discounted value of the maximum income of PPP\$40,000, the following form of Atkinson's formula is used:

$$\begin{aligned} W(y) &= y^* + 2(y^{*1/2}) + 3(y^{*1/3}) + 4(y^{*1/4}) + 5(y^{*1/5}) \\ &\quad + 6(y^{*1/6}) + 7(y^{*1/7}) + 8[(40,000 - 7y^*)^{1/8}] \end{aligned}$$

This is because PPP\$40,000 is between $7y^*$ and $8y^*$. With the above formulation, the discounted value of the maximum income of PPP\$40,000 is PPP\$6,040.

The construction of the HDI is illustrated with two examples—Greece, an industrial country, and Gabon, a developing country.

Country	Life expectancy (years)	Adult literacy (%)	Combined enrolment ratio (%)	Real GDP per capita (PPP\$)
Greece	77.7	93.8	78	8,950
Gabon	53.7	60.3	47	3,861

Life expectancy index

$$\text{Greece} = \frac{77.7 - 25}{85 - 25} = \frac{52.7}{60} = 0.878$$

$$\text{Gabon} = \frac{53.7 - 25}{85 - 25} = \frac{28.7}{60} = 0.478$$

Adult literacy index

$$\text{Greece} = \frac{93.8 - 0}{100 - 0} = \frac{93.8}{100} = 0.938$$

$$\text{Gabon} = \frac{60.3 - 0}{100 - 0} = \frac{60.3}{100} = 0.603$$

Combined primary, secondary and tertiary enrolment ratio index

$$\text{Greece} = \frac{78 - 0}{100 - 0} = 0.780$$

$$\text{Gabon} = \frac{47 - 0}{100 - 0} = 0.470$$

Educational attainment index

$$\text{Greece} = [2(0.938) + 1(0.780)] \div 3 = 0.885$$

$$\text{Gabon} = [2(0.603) + 1(0.470)] \div 3 = 0.558$$

Adjusted real GDP per capita (PPP\$) index

Greece's real GDP per capita, at PPP\$8,950, is above—but less than twice—the threshold. Thus, the adjusted real GDP per capita for Greece would be PPP\$5,825 because $5,825 = [5,711 + 2(8,950 - 5,711)1/2]$.

Gabon's real GDP per capita, at PPP\$3,861, is less than the threshold, so it needs no adjustment.

The adjusted real GDP per capita (PPP\$) index for Greece and Gabon would be:

$$\text{Greece} = \frac{5,825 - 100}{6,040 - 100} = \frac{5,725}{5,940} = 0.964$$

$$\text{Gabon} = \frac{3,861 - 100}{6,040 - 100} = \frac{3,761}{5,940} = 0.633$$

Human development index

The HDI is a simple average of the life expectancy index, educational attainment index and the adjusted real GDP per capita (PPP\$) index. It is calculated by dividing the sum of these three indices by 3. The HDI values for Greece and Gabon are calculated using this formula:

Country	Life expectancy index	Educational attainment index	Adjusted real GDP per capita (PPP\$) index	Σ	HDI
Greece	0.878	0.885	0.964	2.727	0.909
Gabon	0.478	0.558	0.633	1.669	0.557

2. Computing the GDI and the GEM

For comparisons among countries, the gender-related development index (GDI) and the gender empowerment measure (GEM) are limited to data widely available in international data sets. Data disaggregated by gender are scarce, however, and for some indicators we have used the latest available estimate. In addition, for some indicators there are variations in how broadly categories are defined.

For this year's Report we have endeavoured to use the most recent, reliable and internally consistent data. As a result, there have been significant changes in ranking for a few countries compared with last year's Report, most stemming from new estimates of real GDP per capita, wages, labour force participation rates, men's and women's shares of administrative and managerial positions or their shares of professional and technical positions.

Collecting more extensive and more reliable gender-disaggregated data is a challenge that the international community should squarely face. We continue to publish results on the GDI and the GEM—based on the best available estimates—in expectation that it will help increase the demand for such data.

The gender-related development index

The GDI uses the same variables as the HDI. The difference is that the GDI adjusts the average achievement of each country in life expectancy, educational attainment and income in accordance with the disparity in achievement between women and men. For this gender-sensitive adjustment we use a weighting formula that expresses a moderate aversion to inequality, setting the weighting parameter, ϵ , equal to 2. This is the harmonic mean of the male and female values.

The GDI also adjusts the maximum and minimum values for life expectancy, to account for the fact that women tend to live longer than men. For women the maximum value is 87.5 years and the minimum value 27.5 years; for men the corresponding values are 82.5 and 22.5 years.

Calculating the index for income is fairly complex. Female and male shares of earned income are derived from data on the ratio of the average female wage to the average male wage and the female and male percentage shares of the economically active population aged 15 and above. Where data on the wage ratio are not available, we use a value of 75%, the weighted mean of the wage ratio for all countries with wage data. Before income is indexed, the average adjusted real GDP per capita of each country is discounted on the basis of the disparity in the female and male shares of earned income in proportion to the female and male population shares.

The indices for life expectancy, educational attainment and income are added together with equal weight to derive the final GDI value.

Illustration of the GDI methodology

We choose Paraguay to illustrate the steps for calculating the gender-related development index. The parameter of inequality aversion, ϵ , equals 2. (Any discrepancies in results are due to numbers' being rounded up.)

Life expectancy

Females	72.0 years
Males	68.2 years

Adult literacy

Females	89.9%
Males	93.1%

Combined enrolment

Females	61.1%
Males	61.9%

STEP ONE

Computing indices for life expectancy and education

Life expectancy

Females	$(72.0 - 27.5)/60 = 0.7417$
Males	$(68.2 - 22.5)/60 = 0.7617$

Adult literacy

Females	$(89.9 - 0)/100 = 0.899$
Males	$(93.1 - 0)/100 = 0.931$

Combined enrolment

Females	$(61.1 - 0)/100 = 0.611$
Males	$(61.9 - 0)/100 = 0.619$

Educational attainment

Females	$1/3(0.611) + 2/3(0.899) = 0.803$
Males	$1/3(0.619) + 2/3(0.931) = 0.827$

STEP TWO

Computing proportional income shares

Percentage share of economically active population

Females	27.6
Males	72.4

Percentage share of total population

Females	48.9
Males	51.1

Ratio of female non-agricultural wage to male non-agricultural wage: 75.5%

Adjusted real GDP per capita: PPP\$3,340

Ratio of female wage to average wage (W) and of male wage to average wage (W):

$$W = 0.276(0.755) + 0.724(1) = 0.9324$$

$$\text{Female wage to average wage: } 0.755/0.9324 = 0.8098$$

$$\text{Male wage to average wage: } 1.000/0.9324 = 1.0725$$

Share of earned income

Note: $[(\text{female wage/average wage}) \times \text{female share of economically active population}] + [(\text{male wage/average wage}) \times \text{male share of economically active population}] = 1$.

Females	$0.8098 \times 0.276 = 0.2235$
Males	$1.0725 \times 0.724 = 0.7765$

Female and male proportional income shares

Females	$0.2235/0.489 = 0.45705$
Males	$0.7765/0.511 = 1.51957$

STEP THREE

Applying weighting parameter ($\epsilon = 2$)

The equally distributed income index

$$[0.489(0.45705)^{-1} + 0.511(1.51957)^{-1}]^{-1} = 0.7066$$

$$0.7066 \times 3,340 = 2,360$$

$$(2,360 - 100)/(6,040 - 100) = 0.380$$

The equally distributed educational index
 $[0.489(0.803)^{-1} + 0.511(0.827)^{-1}]^{-1} = 0.815$

The equally distributed life expectancy index
 $[0.489(0.7417)^{-1} + 0.511(0.7617)^{-1}]^{-1} = 0.752$

STEP FOUR

Computing the gender-related development index
 $1/3(0.380 + 0.815 + 0.752) = 0.649$

The gender empowerment measure

The GEM uses variables constructed explicitly to measure the relative empowerment of men and women in political and economic spheres of activity.

The first two variables are chosen to reflect economic participation and decision-making power: women's and men's percentage shares of administrative and managerial positions and their percentage shares of professional and technical jobs. These are broad, loosely defined occupational categories. Because the relevant population for each is different, we calculate a separate index for each and then add the two together. The third variable, women's and men's percentage shares of parliamentary seats, is chosen to reflect political participation and decision-making power.

For all three of these variables we use the methodology of population-weighted $(1-\epsilon)$ averaging to derive an "equally distributed equivalent percentage" (EDEP) for both sexes taken together. Each variable is indexed by dividing the EDEP by 50%.

An income variable is used to reflect power over economic resources. It is calculated in the same manner as for the GDI except that unadjusted real GDP per capita is used, rather than adjusted real GDP per capita. The maximum value for income is thus PPP\$40,000 and the minimum PPP\$100.

The three indices—for economic participation and decision-making, political participation and decision-making, and power over economic resources—are added together with equal weight to derive the final GEM value.

Illustration of the GEM methodology

We choose Mexico to illustrate the steps in calculating the gender empowerment measure. The parameter of inequality aversion, ϵ , equals 2. (Any discrepancies in results are due to numbers' being rounded up.)

STEP ONE

Calculating indices for parliamentary representation and administrative and managerial, and professional and technical, positions

Percentage share of parliamentary representation

Females 13.9
 Males 86.1

Percentage share of administrative and managerial positions

Females 20.0
 Males 80.0

Percentage share of professional and technical positions

Females 43.6
 Males 56.4

Percentage share of population

Females 50.1
 Males 49.9

Calculating the EDEP for parliamentary representation

$[0.499(86.1)^{-1} + 0.501(13.9)^{-1}]^{-1} = 23.90$

Calculating the EDEP for administrative and managerial positions

$[0.499(80.0)^{-1} + 0.501(20.0)^{-1}]^{-1} = 31.96$

Calculating the EDEP for professional and technical positions

$[0.499(56.4)^{-1} + 0.501(43.6)^{-1}]^{-1} = 49.168$

Indexing parliamentary representation

$23.90/50 = 0.4780$

Indexing administrative and managerial positions

$31.96/50 = 0.6392$

Indexing professional and technical positions

$49.168/50 = 0.9834$

Combining the indices for administrative and managerial, and professional and technical, positions

$(0.6392 + 0.9834)/2 = 0.8113$

STEP TWO

Calculating the index for share of earned income

Percentage share of economically active population

Females 29.4
 Males 70.6

Ratio of female non-agricultural wage to male non-agricultural wage: 75%

Unadjusted real GDP per capita: PPP\$7,010

Ratio of female wage to average wage (W)

and of male wage to average wage (W):

$W = 0.294(0.75) + 0.706(1) = 0.9265$

Female wage to average wage: $0.75/0.9265 = 0.8095$

Male wage to average wage: $1.00/0.9265 = 1.0793$

Share of earned income

Note: [(female wage/average wage) x female share of economically active population] + [(male wage/average wage) x male share of economically active population] = 1.

Females $0.8095 \times 0.294 = 0.2380$

Males $1.0793 \times 0.706 = 0.7620$

Female and male proportional income shares

Females $0.2380/0.501 = 0.4750$

Males $0.7620/0.499 = 1.5271$

Calculating the equally distributed income index

$[0.499(1.5271)^{-1} + 0.501(0.4750)^{-1}]^{-1} = 0.7239$

$0.7239 \times 7,010 = 5,074$

$(5,074 - 100)/(40,000 - 100) = 0.1247$

STEP THREE

Computing the gender empowerment measure

$1/3(0.4780 + 0.8113 + 0.1247) = 0.471$

3. The capability poverty measure

A person's material standard of living is generally assumed to determine his or her well-being. Consistent with this, poverty is conventionally defined as an unacceptably low material standard of living, either relative to the standard of others in a society or on the basis of some absolute minimum. The standard of living is usually measured using current expenditure or income, and a cut-off line is selected below which people are considered poor.

Since both expenditure and income are measured in money, the choice of the cut-off, or poverty, line is always somewhat arbitrary. There is no clear-cut reason for choosing one value over another. And opinions invariably differ on how much money is necessary to escape poverty. One reason is that money is merely an approximate way to measure the value of goods and services, which are no more than means to human well-being.

What is needed is a more people-centred measure of poverty that recognizes that human deprivation occurs in a number of critical dimensions. Lack of income is just one dimension, and it is focused on means rather than ends. The capability poverty measure (CPM) is a multi-dimensional index of poverty focused on capabilities.

Basic capabilities

Human development is defined by the expansion of capabilities. Unlike income, capabilities are ends, and they are reflected not in inputs, but in human outcomes—in the quality of people's lives. Deprivation is reflected in a lack of basic capabilities—when people are unable to reach a certain level of essential human achievement or functioning.

Leading a life free of avoidable morbidity is one such capability, being informed and educated another, and being well nourished a third. Signalling failures in these capabilities are ill health, illiteracy and very low weight. Another basic capability, one all too often ignored, is healthy reproduction.

Ideally, in measuring deprivation in capabilities, indicators should be used that directly reflect capability shortfalls. But these are often unavailable, and substitute indicators must be used that reflect the means to form or use capabilities. The availability of trained health personnel to attend births is one such indicator. Others are access to health services, to potable water and to adequate sanitation. Another is potential access to food across a population, as reflected in the average per capita calorie supply.

But indicators of actual access are more useful than those of potential access. To monitor the effectiveness of the public health system, for example, rates of immunization or use of oral rehydration therapy are preferable to data showing whether a primary health care centre is within an hour's travel time.

Deprivation in capabilities is the result of lack of opportunity—signifying that society has not provided people with access to the means to develop or maintain essential human capabilities. For example, adequate health services might not be available to ensure that people are protected against avoidable morbidity, or schooling might not be available to ensure literacy and

numeracy. Removing barriers to access or ensuring that access is not merely potential or formal is the responsibility of society.

If indicators of the full range of essential capabilities were available, there would be little need to use an indirect monetary indicator such as income or expenditure to monitor deprivation. These indirect monetary measures are useful for indicating a person's command over the direct means to ensure a decent material standard of living, such as basic food, clothing and shelter and essential energy and transport. Because indicators for these direct means to material welfare are not widely available, income is used as a proxy for these means—as in the human development index.

What is the capability poverty measure?

The capability poverty measure is a simple index composed of three indicators that reflect the percentage of the population with capability shortfalls in three basic dimensions of human development: living a healthy, well-nourished life, having the capability of safe and healthy reproduction and being literate and knowledgeable. The three corresponding indicators are the percentage of children under five who are underweight, the percentage of births unattended by trained health personnel and the percentage of women aged 15 years and above who are illiterate. Technical note table 3.1 presents the CPM and its three components for 101 developing countries. It also compares each country's rank by the CPM with its rank by GDP per capita.

The CPM differs from the HDI in that it focuses on people's lack of capabilities rather than on the average level of capabilities in a country. In addition, the HDI uses income, but the CPM does not. Comparing results of the CPM with those of the HDI would show that some countries have done relatively better in raising average capabilities than in reducing capability poverty—and others have done relatively better in reducing capability poverty than in raising average capabilities.

In the CPM the problem of aggregation across the three variables is solved by choosing variables expressed in terms of the percentage of the relevant population that is poor. The threshold for defining poverty is based on the standard international definition for each variable. Standard definitions for underweight, for trained health personnel and for literacy are already in common use. Other variables with standard definitions, such as the percentage of low-birth-weight babies or the percentage of one-year-olds immunized, could also be used in a capability poverty measure.

The CPM's three variables are given equal weight in the composite index. This assumes that one basic capability is not a substitute for another that is lacking. For such "foundational" capabilities, this is a reasonable assumption, and it implies that policy should not seek to trade one off against another. If flexibility in weights is desired, respondents to household surveys could be asked to assign weights to each capability by allocating a fixed total.

When the percentages for the CPM's three variables are added together, an estimate is derived of the average

capability poverty in a country. In Viet Nam, for example, about 20% of the people are capability poor, on average, in all three dimensions. For some dimensions the percentage may be lower, such as unattended births (5%), and for others it may be higher, such as underweight children (45%). But added together, Viet Nam's record in each dimension is equivalent to a situation in which 20% of the people are deprived in all three dimensions.

A multidimensional measure such as the CPM is a useful tool for analyzing poverty at the household level. By noting the number of households that are poor in a particular dimension, say, in education or nutrition, policy-makers can more effectively target their interventions. In addition, the seriousness of poverty in each household can be assessed by the number of dimensions in which household members are deprived. Households poor in a number of different dimensions should receive priority from policy-makers.

The three variables

The three variables in the CPM cover substantial ground—indications of nutrition and health for the population as a whole (underweight children), access to reproductive health services and a concrete test of access to health services in general (unattended births), and basic educational attainment plus information on gender inequality (female adult illiteracy). Through female illiteracy, for example, countries are evaluated by their treatment of the most deprived group. Rather than trying to be comprehensive by reflecting deprivation in all human priority areas, the index emphasizes critical areas where progress is needed most.

Female literacy signifies the percentage of women aged 15 and above who can, with understanding, read and write a short, simple statement on their everyday life.

The rate of illiteracy among women is an informative variable for assessing the general poverty situation in a country. As is now well known, educating women has a powerful multiplier effect on the well-being of families and on a society's general level of human development. As women become literate, fertility rates fall, infant and child health improves, children's educational level increases and household nutritional and sanitary conditions improve.

The threshold for underweight children is weight that is lower than two standard deviations from the median weight-for-age of an international reference group. This is a powerful variable reflecting lack of opportunity in a number of areas, most important among them health services, safe water, sanitation and adequate food. As an outcome variable, it registers the effect of many input variables.

The percentage of births unattended by trained health personnel is an input variable, but one that is a reliable predictor of such important outcome variables as the maternal mortality rate. The index uses it as a proxy for the capability of safe and healthy reproduction. The definition of trained personnel is broad: it includes physicians, nurses, midwives, trained primary health care workers and trained traditional birth attendants. Despite the broad definition, many countries still record very high percentages of unattended births.

For a few countries estimates had to be generated for the percentage of underweight children or the percentage of unattended births. To estimate the percentage of underweight children, a regression model was used that includes as explanatory variables the percentage of low-birth-weight babies and the under-five mortality rate. For unattended births the explanatory variables are the maternal mortality rate and the infant mortality rate.

TECHNICAL NOTE TABLE 3.1

Capability poverty measure

CPM rank	Capability poverty measure (CPM) value	Births unattended by trained health personnel (%) 1983-94	Underweight children under age five (%) 1985-95	Female illiteracy rate (%) 1993	Real GDP per capita (PPP\$) 1993	Real GDP per capita (PPP\$) rank minus CPM rank ^a	
1	Chile	2.8	2	1	5.5	8,900	8
2	Trinidad and Tobago	4.1	2	7	3.4	8,670	8
3	Uruguay	4.7	4	7	2.6	6,550	12
4	Costa Rica	6.1	7	6	5.4	5,680	16
5	Argentina	6.3	13	2	4.1	8,350	8
6	Barbados	6.5	10 ^b	6	3.6	10,570	1
7	Panama	7.2	4	7	10.5	5,890	11
8	Hong Kong	7.3	0	9 ^b	12.9	21,560	-6
9	Singapore	7.7	0	8 ^b	15.0	19,350	-5
10	Cuba	7.8	10	8	5.4	3,000	32
11	Korea, Rep. of	8.6	11	11 ^b	3.9	9,710	-3
12	United Arab Emirates	9.9	1	7	21.8	20,940	-9
13	Brazil	10.0	5	7	18.0	5,500	9
14	Kuwait	10.8	1	5	26.4	21,630	-13
15	Jamaica	12.3	18	7	11.7	3,180	24
16	Dominican Rep.	12.4	8	10	18.8	3,690	16
17	Mongolia	12.6	1	12	24.4	2,090	41
18	Colombia	13.4	19	12	9.4	5,790	1
19	Jordan	14.2	13	6	23.3	4,380	8
20	Ecuador	15.0	16	17	12.5	4,400	6
21	Venezuela	15.2	31	5	10.1	8,360	-10
22	Paraguay	15.9	34	4	10.1	3,340	13
23	Mexico	16.9	23	14	13.6	7,010	-9
24	China	17.5	6	17	29.1	2,330	26
25	Guyana	18.4	30 ^b	22	3.0	2,140	30
26	Sri Lanka	19.3	6	38	13.8	3,030	15
27	Viet Nam	20.1	5	45	10.5	1,040	50
28	Mauritius	20.6	15	24	22.8	12,510	-22
29	Malaysia	20.6	13	25	23.7	8,360	-17
30	Thailand	21.1	29	26	8.6	6,350	-14
31	Turkey	21.2	24	10	29.1	4,210	-3
32	Zimbabwe	22.3	30	16	21.4	2,100	24
33	Honduras	22.4	19	19	28.8	2,100	24
34	Libyan Arab Jamahiriya	22.9	24	4	40.7	6,125	-17
35	Nicaragua	24.3	27	12	34.1	2,280	16
36	Lebanon	24.9	55	9	10.6	2,500	12
37	Swaziland	25.1	39 ^b	10	26.4	2,940	6
38	Saudi Arabia	25.1	10	13	52.4	12,600	-33
39	El Salvador	25.6	34	11	31.5	2,360	10
40	Peru	25.7	48	11	18.4	3,320	-4
41	Gabon	28.4	20	15	50.1	3,861	-11
42	Philippines	28.8	47	33	6.1	2,590	3
43	Iran, Islamic Rep. of	29.8	30	16	43.6	5,380	-20
44	Tunisia	29.9	31	10	48.4	4,950	-19
45	Botswana	30.4	22	27	42.2	5,220	-21
46	South Africa	30.4	29 ^b	43	19.2	3,127	-6
47	Bolivia	31.6	53	16	26.1	2,510	0
48	Syrian Arab Rep.	32.7	39	12	47.0	4,196	-19
49	Cameroon	33.5	36	14	51.0	2,220	3
50	Kenya	33.8	46	22	33.2	1,400	18
51	Myanmar	34.4	43	37	23.4	650	45
52	Zambia	35.1	49	25	31.3	1,110	22
53	Maldives	35.5	43 ^b	56	7.4	2,200	0
54	Madagascar	36.7	44	39	27.0	700	38
55	Gambia	38.0	20	17	76.9	1,190	18
56	Lesotho	38.6	60	16	40.0	980	24
57	Ghana	39.3	41	27	49.5	2,000	2
58	Tanzania, U. Rep. of	39.4	47	25	46.1	630	40
59	Iraq	39.9	50	12	57.7	3,413	-26
60	Congo	41.7	65 ^b	24	36.2	2,750	-16
61	Cambodia	42.0	53	38	35.0	1,250	10
62	Indonesia	42.3	64	40	23.1	3,270	-25
63	Egypt	43.7	59	9	63.0	3,800	-32
64	Malawi	44.1	45	27	60.2	710	27
65	Sudan	44.3	31	34	68.0	1,350	4

TECHNICAL NOTE TABLE 3.1

Capability poverty measure (continued)

CPM rank	Capability poverty measure (CPM) value	Births unattended by trained health personnel (%) 1983-94	Underweight children under age five (%) 1985-95	Female illiteracy rate (%) 1993	Real GDP per capita (PPP\$) 1993	Real GDP per capita (PPP\$) rank minus CPM rank ^a	
66	Zaire	44.7	66 ^b	33	35.1	300	35
67	Guatemala	45.0	49	34	52.4	3,400	-33
68	Togo	45.4	46	24	65.7	1,020	10
69	Uganda	45.9	62	23	52.3	910	12
70	Central African Rep.	46.0	54	32	52.1	1,050	5
71	Côte d'Ivoire	46.7	55	12	72.6	1,620	-8
72	Liberia	47.1	42	20	79.3	843	12
73	Algeria	49.5	85	9	54.2	5,570	-52
74	Morocco	49.7	69	9	71.2	3,270	-36
75	Papua New Guinea	49.8	80	30	39.4	2,530	-29
76	Senegal	50.9	54	20	78.5	1,710	-15
77	Rwanda	51.5	74	29	51.4	740	12
78	Nigeria	51.6	63	36	56.2	1,540	-12
79	Benin	51.9	55	24	76.8	1,650	-17
80	Lao People's Dem. Rep.	54.6	52 ^b	54	57.9	1,458	-13
81	Guinea	56.0	64	24	79.9	1,800	-21
82	Guinea-Bissau	56.6	73	37 ^b	59.9	860	1
83	Haiti	57.8	80	34	59.5	1,050	-7
84	Mali	59.4	68	31	79.2	530	15
85	Burkina Faso	59.7	58	30	91.6	780	3
86	Mauritania	60.8	60	48	74.7	1,610	-22
87	Pakistan	60.8	65	40	77.0	2,160	-33
88	Chad	61.2	85	31	67.6	690	5
89	India	61.5	67	53	64.0	1,240	-17
90	Sierra Leone	62.3	75	29	83.3	860	-8
91	Yemen	62.7	84	30	74.0	1,600	-26
92	Somalia	63.7	98	39	54.0	712	-2
93	Angola	64.0	85	35	72.0	674	1
94	Burundi	66.1	81	38	79.1	670	1
95	Mozambique	66.9	75	47	78.6	640	2
96	Bhutan	68.2	93	38	73.8	790	-9
97	Ethiopia	70.1	86	48	76.5	420	3
98	Niger	71.7	85	36	93.9	790	-12
99	Afghanistan	72.5	91	40	86.5	819	-14
100	Bangladesh	76.9	90	66	75.0	1,290	-30
101	Nepal	77.3	94	51	87.0	1,000	-22

a. A positive figure indicates that the CPM rank is better than the real GDP per capita (PPP\$) rank, a negative the opposite.

b. Human Development Report Office estimate.

Source: Column 2: UNICEF 1996; column 3: WHO 1995a and UN 1992; column 4: UNESCO 1995b; column 5: calculated on the basis of estimates from World Bank 1995h.

4. Links between economic growth and human development

A cross-country econometric exercise was carried out to examine the strength of the link between human development and economic growth. The first part of the exercise examined the effect of economic growth, social expenditure and income distribution on the levels of and changes in two human development indicators—life expectancy and child mortality. The second examined the inverse links, by looking at the effect of life expectancy, gross domestic investment and income distribution on growth. The results confirm the positive, two-way relationship between human development and economic growth. They also show the importance of other factors, such as social expenditure and income distribution, in determining the levels of and the rates of improvement in human development indicators.

The analysis used lags of the original variables as instruments to remove the bias that would result from applying the ordinary least squares technique to the system of equations, which have a clear, two-way flow of influence. Lag values are reasonable candidates as instruments because the correlation between the two periods analysed in the residuals in the human development and growth regressions is never substantial.

Equation 1 regresses the percentage reduction in life expectancy shortfall (from a maximum of 85 years) between 1970 and 1992 on the average real GDP per capita growth rate in 1960–70, average social expenditure in the 1970s (defined as the percentage of GDP invested in health and education) and the average income share of the poorest 20% of the population in 1960–70. Equation 2 regresses the percentage reduction in the child mortality rate between 1980 and 1993 on the log of the child mortality rate in 1980 and the real GDP per capita growth rate, average social expenditure and average income share of the poorest quintile in 1970–80.

Equations 3 and 4 regress the logs of life expectancy in 1992 and child mortality in 1993 on the log of GDP per capita in 1980 and average social expenditure and average income share of the poorest quintile in 1970–90. Equation 5 regresses the average real GDP per capita growth rate for 1970–92 on the log of GDP per capita in 1960, the log of life expectancy in 1967, average gross domestic investment in 1970–75 and the average income share of the poorest 20% of the population in 1960–70. The data used in the analysis are from the World Bank (1994a) and UNICEF (1995).

From economic growth to human development

(ordinary least squares; t-statistics are given in parentheses)

1. Percentage reduction in life expectancy shortfall
 $= 0.21 + 2.22 \text{ GDP}/n \text{ growth rate}$
 (3.7) (3.4)
 $+ 0.95 \text{ social expenditure}$
 (2.0)
 $- 0.97 \text{ income share of poorest 20\%}$
 (-1.3)
 Adj. $R^2 = 0.24$ $n = 58$

2. Percentage reduction in child mortality
 $= -5.38 + 0.62 \log (\text{child mortality rate})$
 (-4.1) (3.5)
 $+ 16.51 \text{ GDP}/n \text{ growth rate}$
 (2.7)
 $+ 23.99 \text{ social expenditure}$
 (3.7)
 $+ 13.2 \text{ income share of poorest 20\%}$
 (1.93)
 Adj. $R^2 = 0.25$ $n = 54$

3. $\log (\text{life expectancy})$
 $= 3.14 + 0.13 \log (\text{GDP}/n)$
 (39.5) (11.1)
 $+ 0.03 \text{ social expenditure}$
 (0.1)
 $- 0.31 \text{ income share of poorest 20\%}$
 (-0.7)
 Adj. $R^2 = 0.77$ $n = 66$

4. $\log (\text{child mortality})$
 $= 12.21 - 0.99 \log (\text{GDP}/n)$
 (22.2) (-13.8)
 $- 3.53 \text{ social expenditure}$
 (-1.98)
 $- 7.04 \text{ income share of poorest 20\%}$
 (-2.5)
 Adj. $R^2 = 0.794$ $n = 81$

From human development to economic growth

5. Average GDP/ n annual growth rate
 $= -0.30 - 0.02 \log (\text{GDP}/n)$
 (-4.2) (-3.3)
 $+ 0.11 \log (\text{life expectancy})$
 (4.5)
 $- 0.01 \text{ gross domestic investment}$
 (-0.4)
 $+ 0.16 \text{ income share of poorest 20\%}$
 (1.0)
 Adj. $R^2 = 0.371$ $n = 38$

Equations 1 and 2 show that a 1 percentage point increase in the average growth rate of GDP per capita is estimated to reduce the life expectancy shortfall by 2.2 percentage points and the child mortality rate by 16 percentage points. This means, for example, that a 2 percentage point increase in the GDP per capita growth rate of a country with an average life expectancy in 1970 of 57 years would increase its life expectancy by an additional 1.5 years. And a 1 percentage point increase in the GDP per capita growth rate of a country with a child mortality rate of 115 per thousand live births in 1980 would reduce child mortality by an additional 18 deaths per thousand live births.

The share of GDP invested in health and education also has a significant and positive effect on the rates of improvement in human development indicators. A 1 percentage point increase in the average share of GDP invested in health and education is estimated to reduce the life expectancy shortfall by 1 percentage point and the child mortality rate by 24 percentage points. Thus, if a

country with the average life expectancy and child mortality rate in 1970 increases social expenditure by 3 percentage points, its life expectancy would increase by one additional year and its child mortality rate would decrease by 83 deaths per thousand live births.

A more equal income distribution was also shown to have a positive and significant effect on the rate of improvement in the child mortality rate. A 1 percentage point increase in the income share of the poorest quintile is associated with a 13 percentage point reduction in the child mortality rate.

Income per capita, social expenditure and income distribution are also significantly correlated with the levels of these indicators. A 1% increase in GDP per capita is associated with a 0.13% increase in the 1992 life expectancy and a 1% reduction in the 1993 child mortality rate. A 1 percentage point increase in social expenditure is associated with a 3% reduction in the child mortality rate, and a 1 percentage point increase in the income share of the poorest quintile with a 7% reduction.

The analysis also tested the links from human development to economic growth. The results show that the effect of human development on economic growth is also positive and significant. A 10% increase in life expectancy, equal to 5.7 years in 1970, is estimated to raise the average GDP per capita growth rate by 1.1 percentage points a year. Results for other human development indicators

also show a positive and significant effect on the income per capita growth rate. The results are consistent with many other cross-country studies on the determinants of income growth.

These empirical results show that growth in income, increases in social expenditure and a more equal income distribution are all important determinants of human development. The higher the growth rate of income and the share of GDP invested in health and education, and the more equal the distribution of income, the higher the rate of improvement in human development indicators is expected to be. The higher the GDP per capita, the lower the child mortality rate and the higher the life expectancy at birth. And the higher the social expenditure and the more equal the distribution of income, the lower the child mortality rate.

In turn, human development was found to be an important determinant of the rate of income growth—the higher the life expectancy, the higher the per capita income growth rate. The importance of analysing the determinants of income growth lies, of course, in the fact that many human capabilities are crucially dependent on people's economic circumstances. Thus, although certain basic human capabilities, such as life expectancy, enter as inputs into the growth equation, they are primarily ends in themselves, while economic growth is the means for further expanding capabilities.