Measurement and Dimensions of Human Development

There are two basic views about human development.

1. A few believe it as increase in the quality of life with other values like equity, basic human rights and so on. They also concern about equality between and within generations - and to that degree with *sustainable* human development. This broad approach is being even pursued in the UNDP's *HDRs*.
2. Others believe that human development focus primarily on basic needs and well-being and are not concerned with other values.

- Both the views focuses on *direct* measures of the quality of life.

Human Development Index

- In some basic respects the world is a much better place today than it was in 1990 or in 1970.
- Of 135 countries in UNDP's sample for 1970–2010, with 92 percent of the world's people, only 3-the Democratic Republic of the Congo, Zambia and Zimbabwe- have a lower HDI today than in 1970.
- Not all countries have progressed rapidly, and the variation is striking. Over the past 40 years a quarter of developing countries saw their HDI increase less than 20 percent, another quarter, more than 65 percent. These differences partly reflect different starting points-less developed countries have on average faster progress in health and education than more developed ones do.

- But half the variation in HDI performance is unexplained by initial HDI, and countries with similar starting points experience remarkably different evolutions, suggesting that country factors such as policies, institutions and geography are important.
- Progress in income varies much more. Despite aggregate progress, there is no convergence in income in contrast to health and education. Because, on average, rich countries have grown faster than poor ones over the past 40 years.
- The divide between developed and developing countries persists: a small subset of countries has remained at the top of the world income distribution, and only a handful of countries that started out poor have joined that high-income group.

- Research shows the lack of a significant correlation between economic growth and improvements in health and education.
- Income is critical in determining people's command over the resources necessary to gain access to food, shelter and clothing and in making possible much broader options-such as working in meaningful and intrinsically rewarding activities or spending more time with loved ones.
- Income growth can indicate that opportunities for decent work are expanding, though this is not always so, and economic contractions and associated job losses are bad news for people around the world.
- Income is also the source of the taxes and other revenues that governments need in order to provide services and undertake redistributive programs. Thus, increasing income on a broad basis remains an important policy priority.

Role of institutions:

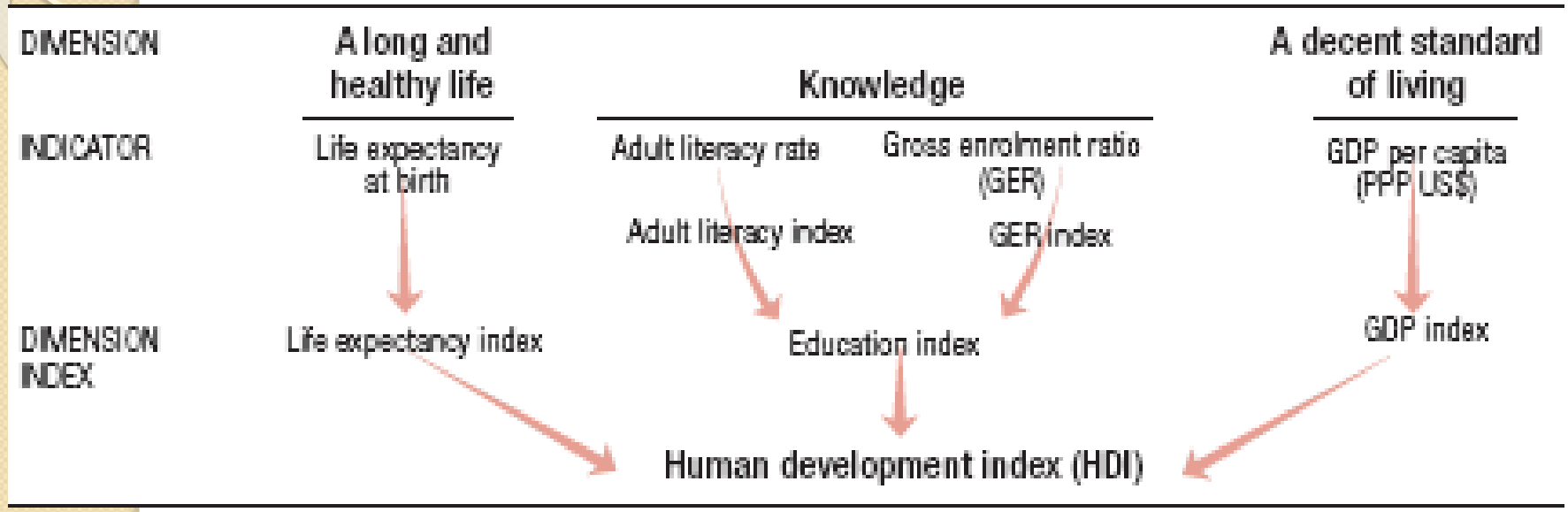
- The economic liberalization in India sought to ease an overly restrictive and family-dominated business environment by reducing regulation and introducing more competition. In short, while institutions are a key determinant of human development, how they interact with their context merits careful investigation.
- One important aspect is how relationships between markets and states are organized. Governments have addressed, in a range of ways, the tension between the need for markets to generate income and dynamism and the need to deal with market failures.
- Markets may be necessary for sustained economic dynamism, but they do not automatically bring progress in other dimensions of human development.
- Development that overly favours rapid economic growth is rarely sustainable. In other words, a market economy is necessary, but not enough.

- For example, firms that produce cheap labour-intensive goods or that exploit natural resources may not want a more educated workforce and may care little about their workers' health if there is an abundant pool of labour.
- Without complementary societal and state action, markets can be weak on environmental sustainability, creating the conditions for environmental degradation, even for such disasters as mud flows in Java and oil spills in the Gulf of Mexico.
- Regulation, however, requires a capable state as well as political commitment, and state capability is often in short supply. Some developing country governments have tried to mimic the actions of a modern developed state without having the resources or the capacity to do so. For example, import substitution regimes in many Latin American countries floundered when countries tried to develop a targeted industrial policy.

Human Development

- Human development is not only about health, education and income—it is also about people's active engagement in shaping development, equity and sustainability, intrinsic aspects of the freedom people have to lead lives they have reason to value.
- Lack of quantification is no reason to neglect or ignore some of the areas.

Human Development Index



The human development index (HDI)

The HDI is a summary measure of human development. It measures the average achievements in a country in three basic dimensions of human development:

- A long and healthy life, as measured by life expectancy at birth.
- Knowledge, as measured by the adult literacy rate (with two-thirds weight) and the combined primary, secondary and tertiary gross enrolment ratio (with one-third weight).
- A decent standard of living, as measured by GDP per capita in purchasing power parity (PPP) terms in US dollars.

Before the HDI itself is calculated, an index needs to be created for each of these dimensions. To calculate these indices—the life expectancy, education and GDP indices—minimum and maximum values (goalposts) are chosen for each underlying indicator.

Performance in each dimension is expressed as a value between 0 and 1 by applying the following general formula:

$$\text{Dimension index} = \frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

The HDI is then calculated as a simple average of the dimension indices. The box on the right illustrates the calculation of the HDI for a sample country.

Goalposts for calculating the HDI

Indicator	Maximum value	Minimum value
Life expectancy at birth (years)	85	25
Adult literacy rate (%)*	100	0
Combined gross enrolment ratio (%)	100	0
GDP per capita (PPP US$)	40,000	100

* The goalpost for calculating adult literacy implies the maximum literacy rate is 100%. In practice, the HDI is calculated using an upper bound of 99%.

Calculating HDI: Turkey

1. Calculating the life expectancy index

The life expectancy index measures the relative achievement of a country in life expectancy at birth. For Turkey, with a life expectancy of 71.4 years in 2005, the life expectancy index is 0.773.

$$\text{Life expectancy index} = \frac{71.4 - 25}{85 - 25} = 0.773$$

2. Calculating the education index

The education index measures a country's relative achievement in both adult literacy and combined primary, secondary and tertiary gross enrolment. First, an index for adult literacy and one for combined gross enrolment are calculated. Then these two indices are combined to create the education index, with two-thirds weight given to adult literacy and one-third weight to combined gross enrolment. For Turkey, with an adult literacy rate of 87.4% in 2005 and a combined gross enrolment ratio of 68.7% in 2005, the education index is 0.812.

$$\text{Adult literacy index} = \frac{87{,}4 - 0}{100 - 0} = 0.874$$

$$\text{Gross enrolment index} = \frac{68{,}7 - 0}{100 - 0} = 0.687$$

$$\text{Education index} = 2/3\ (\text{adult literacy index}) + 1/3\ (\text{gross enrolment index})$$
$$= 2/3\ (0{,}874) + 1/3\ (0{,}687) = \mathbf{0{,}812}$$

3. Calculating the GDP index

The GDP index is calculated using adjusted GDP per capita (PPP US$). In the HDI income serves as a surrogate for all the dimensions of human development not reflected in a long and healthy life and in knowledge. Income is adjusted because achieving a respectable level of human development does not require unlimited income. Accordingly, the logarithm of income is used. For Turkey, with a GDP per capita of 8,407 (PPP US$) in 2005, the GDP index is 0.740.

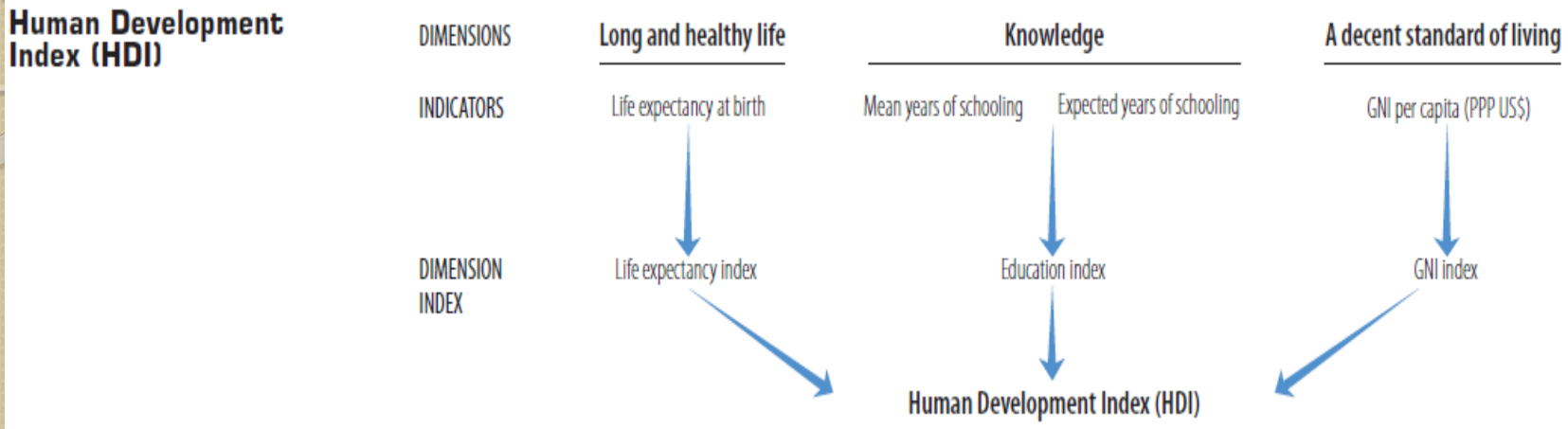
$$\text{GDP index} = \frac{\log(8{,}407) - \log(100)}{\log(40{,}000) - \log(100)} = \mathbf{0.740}$$

4. Calculating the HDI

Once the dimension indices have been calculated, determining the HDI is straightforward. It is a simple average of the three dimension indices.

HDI = 1/3 (life expectancy index) + 1/3 (education index)
+ 1/3 (GDP index)
= 1/3 (0.773) + 1/3 (0.812) + 1/3 (0.740) = 0.775

Modified Human Development Index (HDI)



Goalposts for the Human Development Index

Dimension	Observed maximum	Minimum
Life expectancy	83.2 (Japan, 2010)	20.0
Mean years of schooling	13.2 (United States, 2000)	0
Expected years of schooling	20.6 (Australia, 2002)	0
Combined education index	0.951 (New Zealand, 2010)	0
Per capita income (PPP $)	108,211 (United Arab Emirates, 1980)	163 (Zimbabwe, 2008)

The HDI is the geometric mean of the three dimension indices:

$$(I_{Life}{}^{1/3} \cdot I_{Education}{}^{1/3} \cdot I_{Income}{}^{1/3}). \qquad (2)$$

Expression 2 embodies imperfect substitutability across all HDI dimensions. It thus addresses one of the most serious criticisms of the linear aggregation formula, which allowed for perfect substitution across dimensions. Some substitutability is inherent in the definition of any index that increases with the values of its components.

Example: China

Indicator	Value
Life expectancy at birth (years)	73.5
Mean years of schooling (years)	7.5
Expected years of schooling (years)	11.4
GNI per capita (PPP US$)	7,263

Note: Values are rounded.

$$\text{Life expectancy index} = \frac{73.5 - 20}{83.2 - 20} = 0.847$$

$$\text{Mean years of schooling index} = \frac{7.5 - 0}{13.2 - 0} = 0.568$$

$$\text{Expected years of schooling index} = \frac{11.4 - 0}{20.6 - 0} = 0.553$$

$$\text{Education index} = \frac{\sqrt{0.568 \cdot 0.553} - 0}{0.951 - 0} = 0.589$$

$$\text{Income index} = \frac{\ln(7{,}263) - \ln(163)}{\ln(108{,}211) - \ln(163)} = 0.584$$

$$\text{Human Development Index} = \sqrt[3]{0.847 \cdot 0.589 \cdot 0.584} = 0.663$$

Human Poverty Index for Developing Countries (HPI 1)

While the HDI measures average achievement, the HPI-1 measures *deprivations* in the three basic dimensions of human development captured in the HDI:

- A long and healthy life—vulnerability to death at a relatively early age, as measured by the probability at birth of not surviving to age 40.
- Knowledge—exclusion from the world of reading and communications, as measured by the adult illiteracy rate.
- A decent standard of living—lack of access to overall economic provisioning, as measured by the unweighted average of two indicators, the percentage of the population not using an improved water source and the percentage of children under weight-for-age.

Calculating the HPI-1 is more straightforward than calculating the HDI. The indicators used to measure the deprivations are already normalized between 0 and 100 (because they are expressed as percentages), so there is no need to create dimension indices as for the HDI.

Calculating the HPI-1

1. Measuring deprivation in a decent standard of living

An unweighted average of two indicators is used to measure deprivation in a decent standard of living.

Unweighted average = 1/2 (population not using an improved water source)
+ 1/2 (children under weight-for-age)

A sample calculation: Bolivia

Percentage of population not using an improved water source = 15%

Percentage of children under weight-for-age = 8%

Unweighted average = 1/2 (15) + 1/2 (8) = 11.3%

2. Calculating the HPI-1

The formula used to calculate the HPI-1 is as follows:

$$\text{HPI-1} = [1/3\,(P_1^{\alpha} + P_2^{\alpha} + P_3^{\alpha})]^{1/\alpha}$$

Where:

P_1 = Probability at birth of not surviving to age 40 (times 100)

P_2 = Adult illiteracy rate

P_3 = Unweighted average of population not using an improved water source and children under weight-for-age

$\alpha = 3$

A sample calculation: Bolivia

$P_1 = 15.5\%$

$P_2 = 13{,}3\%$

$P_3 = 11.3\%$

$$\text{HPI-1} = [1/3\,(15{,}5^3 + 13{,}3^3 + 11{,}3^3)]^{1/3} = \mathbf{13{,}6}$$

Human Poverty Index for selected OECD Countries (HPI 2)

The HPI-2 measures deprivations in the same dimensions as the HPI-1 and also captures social exclusion. Thus it reflects deprivations in four dimensions:

- A long and healthy life—vulnerability to death at a relatively early age, as measured by the probability at birth of not surviving to age 60.

- Knowledge—exclusion from the world of reading and communications, as measured by the percentage of adults (ages 16–65) lacking functional literacy skills.
- A decent standard of living—as measured by the percentage of people living below the income poverty line (50% of the median adjusted household disposable income).
- Social exclusion—as measured by the rate of long-term unemployment (12 months or more).

Calculating the HPI-2

The formula used to calculate the HPI-2 is as follows:

$$HPI\text{-}2 = [1/4\ (P_1^{\alpha} + P_2^{\alpha} + P_3^{\alpha} + P_4^{\alpha})]^{1/\alpha}$$

Where:

P_1 = Probability at birth of not surviving to age 60 (times 100)

P_2 = Percentage of adults lacking functional literacy skills

P_3 = Percentage of population below income poverty line (50% of median adjusted household disposable income)

P_4 = Rate of long-term unemployment (lasting 12 months or more)

$\alpha = 3$

A sample calculation: Canada

$P_1 = 8{,}1\%$

$P_2 = 14{,}6\%$

$P_3 = 11{,}4\%$

$P_4 = 0{,}5\%$

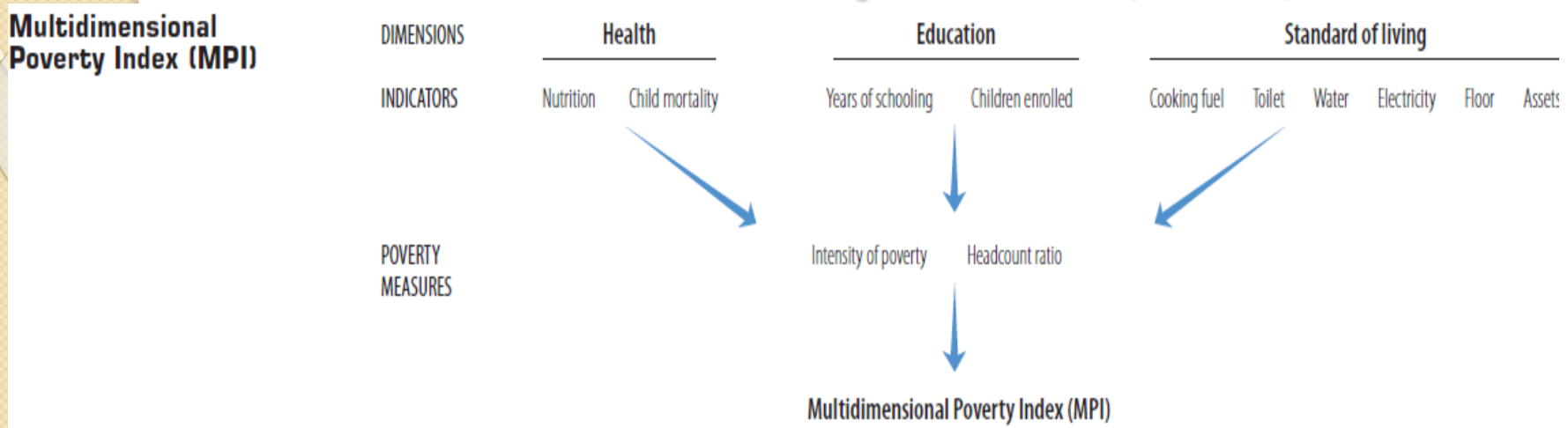
$$HPI\text{-}2 = [1/4\ (8.1^3 + 14.6^3 + 11.4^3 + 0.5^3)]^{1/3} = \mathbf{10.9}$$

Why $\alpha = 3$ in calculating the HPI-1 and HPI-2

The value of α has an important impact on the value of the HPI. If $\alpha = 1$, the HPI is the average of its dimensions. As α rises, greater weight is given to the dimension in which there is the most deprivation. Thus as α increases towards infinity, the HPI will tend towards the value of the dimension in which deprivation is greatest (for Bolivia, the example used to calculate the HPI-1, would be 15.5, equal to the probability at birth of not surviving to age 40).

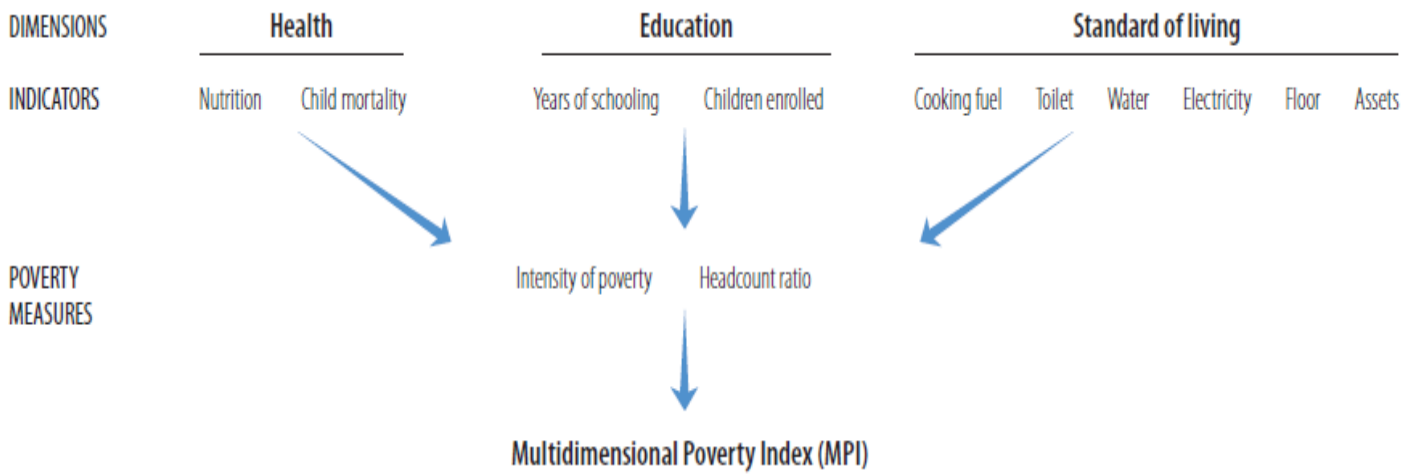
In this Report the value 3 is used to give additional but not overwhelming weight to areas of more acute deprivation. For a detailed analysis of the HPI's mathematical formulation, see Sudhir Anand and Amartya Sen's "Concepts of Human Development and Poverty: A Multidimensional Perspective" and the technical note in *Human Development Report 1997* (see the list of selected readings at the end of this technical note).

Multidimensional Poverty Index (MPI)



Calculating the Multidimensional Poverty Index

Multidimensional Poverty Index (MPI)



- The Multidimensional Poverty Index (MPI) identifies multiple deprivations at the individual level in health, education and standard of living. It uses micro data from household surveys, and-unlike the Inequality-adjusted Human Development Index-all the indicators needed to construct the measure must come from the same survey.
- Each person in a given household is classified as poor or non-poor depending on the number of deprivations his or her household experiences. These data are then aggregated into the national measure of poverty.
- Each person is assigned a score according to his or her household's deprivations in each of the 10 component indicators, (*d*).

- The maximum score is 10, with each dimension equally weighted (thus the maximum score in each dimension is 3⅓).
- The health and education dimensions have two indicators each, so each component is worth 5/3 (or 1.67).
- The standard of living dimension has six indicators, so each component is worth 5/9 (or 0.56).
- The health thresholds are having at least one household member who is malnourished and having had one or more children die.
- The education thresholds are having no household member who has completed five years of schooling and having at least one school-age child (up to grade 8) who is not attending school.

- The standard of living thresholds relate to not having electricity, not having access to clean drinking water, not having access to adequate sanitation, using “dirty” cooking fuel (dung, wood or charcoal), having a home with a dirt floor, and owning no car, truck or similar motorized vehicle, and owning at most one of these assets: bicycle, motorcycle, radio, refrigerator, telephone or television.
- To identify the multidimensionally poor, the deprivation scores for each household are summed to obtain the household deprivation, *c*.
- A cut-off of 3, which is the equivalent of one-third of the indicators, is used to distinguish between the poor and nonpoor.

- Technically this would be 3.33. Because of the weighting structure, the same households are identified as poor if a cut-off of 3 is used.
- If c is 3 or greater, that household (and everyone in it) is multidimensionally poor. Households with a deprivation count between 2 and 3 are vulnerable to or at risk of becoming multidimensionally poor.
- The MPI value is the product of two measures: the multidimensional headcount ratio and the intensity (or breadth) of poverty.
- The headcount ratio, *H, is the proportion of the population* who are multidimensionally poor:

$$H = \frac{q}{n}$$

- where q is the number of people who are multidimensionally poor and n is the total population.

- The intensity of poverty, A, reflects the proportion of the weighted component indicators, d, in which, on average, poor people are deprived.
- For poor households only, the deprivation scores are summed and divided by the total number of indicators and by the total number of poor persons:

$$A = \frac{\sum_1^q c}{qd}$$

- where c is the total number of weighted deprivations the poor experience and d is the total number of component indicators considered (10 in this case).

Example using hypothetical data

Indicators	Household 1	2	3	4	Weights
Household size	4	7	5	4	
Health					
At least one member is malnourished	0	0	1	0	5/3=1.67
One or more children have died	1	1	0	1	5/3=1.67
Education					
No one has completed five years of schooling	0	1	0	1	5/3=1.67
At least one school-age child not enrolled in school	0	1	0	0	5/3=1.67
Living conditions					
No electricity	0	1	1	1	5/9=0.56
No access to clean drinking water	0	0	1	0	5/9=0.56
No access to adequate sanitation	0	1	1	0	5/9=0.56
House has dirt floor	0	0	0	0	5/9=0.56
Household uses "dirty" cooking fuel (dung, firewood or charcoal)	1	1	1	1	5/9=0.56
Household has no car and owns at most one of: bicycle, motorcycle, radio, refrigerator, telephone or television	0	1	0	1	5/9=0.56
Results					
Weighted count of deprivation, c (sum of each deprivation multiplied by its weight)	2.22	7.22	3.89	5.00	
Is the household poor ($c > 3$)?	No	Yes	Yes	Yes	

Note: 1 indicates deprivation in the indicator; 0 indicates non-deprivation.

Weighted count of deprivations in household 1:

$$\left(1 \cdot \frac{5}{3}\right) + \left(1 \cdot \frac{5}{9}\right) = 2.22$$

Headcount ratio

$$(H) = \left(\frac{7+5+4}{4+7+5+4}\right) = 0.80$$

(80 percent of people live in poor households)

Intensity of poverty

$$(A) = \frac{(7.22 \cdot 7) + (3.89 \cdot 5) + (5.00 \cdot 4)}{(7+5+4) \cdot 10} = 0.56$$

(the average poor person is deprived in 56 percent of the weighted indicators).

$$\text{MPI} = H \cdot A = 0.450$$

In sum, the basic intuition is that the MPI represents the share of the population that is multidimensionally poor, adjusted by the intensity of the deprivations suffered.

The gender-related development index (GDI)

While the HDI measures average achievement, the GDI adjusts the average achievement to reflect the *inequalities* between men and women in the following dimensions:

- A long and healthy life, as measured by life expectancy at birth.
- Knowledge, as measured by the adult literacy rate and the combined primary, secondary and tertiary gross enrolment ratio.
- A decent standard of living, as measured by estimated earned income (PPP US$).

The calculation of the GDI involves three steps. First, female and male indices in each dimension are calculated according to this general formula:

$$\text{Dimension index} = \frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

Second, the female and male indices in each dimension are combined in a way that penalizes differences in achievement between men and women. The resulting index, referred to as the equally distributed index, is calculated according to this general formula:

$$\text{Equally distributed index} = \{[\text{female population share} \times (\text{female index}^{1-\varepsilon})] + [\text{male population share} \times (\text{male index}^{1-\varepsilon})]\}^{1/1-\varepsilon}$$

ϵ measures the aversion to inequality. In the GDI $\epsilon = 2$. Thus the general equation becomes:

$$\text{Equally distributed index} = \{[\text{female population share} \cdot (\text{female index}^{-1})] + [\text{male population share} \cdot (\text{male index}^{-1})]\}^{-1}$$

which gives the harmonic mean of the female and male indices.

Third, the GDI is calculated by combining the three equally distributed indices in an unweighted average.

Why $\epsilon = 2$ in calculating the GDI

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 $\epsilon = 0$, 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 (as well as the GEM). This value places a moderate penalty on gender inequality in achievement.

For a detailed analysis of the GDI's mathematical formulation, see Sudhir Anand and Amartya Sen's "Gender Inequality in Human Development: Theories and Measurement," Kalpana Bardhan and Stephan Klasen's "UNDP's Gender-Related Indices: A Critical Review" and the technical notes in *Human Development Report 1995* and *Human Development Report 1999* (see the list of selected readings at the end of this technical note).

Goalposts for calculating the GDI

Indicator	Maximum value	Minimum value
Female life expectancy at birth (years)	87.5	27.5
Male life expectancy at birth (years)	82.5	22.5
Adult literacy rate (%)	100	0
Combined gross enrolment ratio (%)	100	0
Estimated earned income (PPP US$)	40,000	100

Note: The maximum and minimum values (goalposts) for life expectancy are 5 years higher for women to take into account their longer life expectancy. To preserve the relationship between female and male values of each indicator, scaled values are computed and used in place of figures where either the female or male value exceeds the threshold (in the case of Adult Literacy a practical threshold value of 99% is used). The scaling is achieved by multiplying the female and male values by the practical threshold value divided by the maximum reported value for either females or males.

1. Calculating the equally distributed life expectancy index

The first step is to calculate separate indices for female and male achievements in life expectancy, using the general formula for dimension indices.

FEMALE
Life expectancy: 48.4 years

$$\text{Life expectancy index} = \frac{48{,}4 - 27{,}5}{87{,}5 - 27{,}5} = 0{,}348$$

MALE
Life expectancy: 47.6 years

$$\text{Life expectancy index} = \frac{47{,}6 - 22{,}5}{82{,}5 - 22{,}5} = 0{,}419$$

Next, the female and male indices are combined to create the equally distributed life expectancy index, using the general formula for equally distributed indices.

FEMALE
Population share: 0.504
Life expectancy index: 0.348

MALE
Population share: 0.496
Life expectancy index: 0.419

$$\text{Equally distributed life expectancy index} = \{[0.504\ (0.348^{-1})] + [0.496\ (0.419^{-1})]\}^{-1} = \mathbf{0.380}$$

2. Calculating the equally distributed education index

First, indices for the adult literacy rate and the combined primary, secondary and tertiary gross enrolment ratio are calculated separately for females and males. Calculating these indices is straightforward, since the indicators used are already normalized between 0 and 100.

FEMALE	MALE
Adult literacy rate: 81.8%	Adult literacy rate: 80.4%
Adult literacy index: 0,818	Adult literacy index: 0,804
Gross enrolment ratio: 70.1%	Gross enrolment ratio: 69.0%
Gross enrolment index: 0.701	Gross enrolment index: 0.690

Second, the education index, which gives two-thirds weight to the adult literacy index and one-third weight to the gross enrolment index, is computed separately for females and males.

$$\text{Education index} = 2/3\ (\text{adult literacy index}) + 1/3\ (\text{gross enrolment index})$$

$$\text{Female education index} = 2/3\ (0{,}818) + 1/3\ (0{,}701) = 0{,}779$$

$$\text{Male education index} = 2/3\ (0{,}804) + 1/3\ (0{,}690) = 0{,}766$$

Finally, the female and male education indices are combined to create the equally distributed education index.

FEMALE	MALE
Population share: 0,504	Population share: 0,496
Education index: 0.779	Education index: 0.766

$$\text{Equally distributed education index} = \{[0{,}504\ (0{,}779^{-1})] + [0{,}496\ (0{,}766^{-1})]\}^{-1} = \mathbf{0.773}$$

3. Calculating the equally distributed income index

First, female and male earned income (PPP US$) are estimated (for details on this calculation, see the addendum to this technical note). Then the income index is calculated for each gender. As with the HDI, income is adjusted by taking the logarithm of estimated earned income (PPP US$):

$$\text{Income index} = \frac{\log(\text{actual value}) - \log(\text{minimum value})}{\log(\text{maximum value}) - \log(\text{minimum value})}$$

FEMALE
Estimated earned income (PPP US$): 5,913

$$\text{Income index} = \frac{\log(5{,}913) - \log(100)}{\log(40{,}000) - \log(100)} = 0{,}681$$

MALE
Estimated earned income (PPP US$): 19,094

$$\text{Income index} = \frac{\log(19{,}094) - \log(100)}{\log(40{,}000) - \log(100)} = 0{,}877$$

Second, the female and male income indices are combined to create the equally distributed income index:

FEMALE
Population share: 0.504
Income index: 0.681

MALE
Population share: 0.496
Income index: 0.877

$$\text{Equally distributed income index} = \{[0.504\ (0.681^{-1})] + [0.496\ (0.877^{-1})]\}^{-1} = 0.766$$

4. Calculating the GDI

Calculating the GDI is straightforward. It is simply the unweighted average of the three component indices—the equally distributed life expectancy index, the equally distributed education index and the equally distributed income index.

$$\text{GDI} = 1/3\ (\text{life expectancy index}) + 1/3\ (\text{education index}) + 1/3\ (\text{income index})$$

$$= 1/3\ (0.380) + 1/3\ (0.773) + 1/3\ (0.766) = 0.639$$

Gender Empowerment Measure

Focusing on women's opportunities rather than their capabilities, the GEM captures gender inequality in three key areas:

- Political participation and decision-making power, as measured by women's and men's percentage shares of parliamentary seats.
- Economic participation and decision-making power, as measured by two indicators—women's and men's percentage shares of positions as legislators, senior officials and managers and women's and men's percentage shares of professional and technical positions.
- Power over economic resources, as measured by women's and men's estimated earned income (PPP US$).

For each of these three dimensions, an equally distributed equivalent percentage (EDEP) is calculated, as a population-weighted average, according to the following general formula:

$$\text{EDEP} = = \{[\text{female population share } (\text{female index}^{1-\epsilon})] + [\text{male population share } (\text{male index}^{1-\epsilon})]\}^{1/1-\epsilon}$$

ϵ measures the aversion to inequality. In the GEM (as in the GDI) $\epsilon = 2$, which places a moderate penalty on inequality. The formula is thus:

$$\text{EDEP} = \{[\text{female population share } (\text{female index}^{-1})] + [\text{male population share } (\text{male index}^{-1})]\}^{-1}$$

For political and economic participation and decision-making, the EDEP is then indexed by dividing it by 50. The rationale for this indexation is that in an ideal society, with equal empowerment of the sexes, the GEM variables would equal 50%—that is, women's share would equal men's share for each variable.

Where a male or female index value is zero, the EDEP according to the above formula is not defined. However, the limit of EDEP, when the index tends towards zero, is zero. Accordingly, in these cases the value of the EDEP is set to zero.

Calculating the GEM

This illustration of the calculation of the GEM uses data for the Russian Federation.

1. Calculating the EDEP for parliamentary representation

The EDEP for parliamentary representation measures the relative empowerment of women in terms of their political participation. The EDEP is calculated using the female and male shares of the population and female and male percentage shares of parliamentary seats according to the general formula.

FEMALE	MALE
Population share: 0.536	Population share: 0.464
Parliamentary share: 8.0%	Parliamentary share: 92.0%

$$\text{EDEP for parliamentary representation} = \{[0.536\ (8.0^{-1})] + [0.464\ (92.0^{-1})]\}^{-1} = 13.88$$

Then this initial EDEP is indexed to an ideal value of 50%.

$$\text{Indexed EDEP for parliamentary representation} = \frac{13.88}{50} = \mathbf{0.278}$$

2. Calculating the EDEP for economic participation

Using the general formula, an EDEP is calculated for women's and men's percentage shares of positions as legislators, senior officials and managers, and another for women's and men's percentage shares of professional and technical positions. The simple average of the two measures gives the EDEP for economic participation.

FEMALE	MALE
Population share: 0,536	Population share: 0,464
Percentage share of positions as legislators, senior officials and managers: 39.0%	Percentage share of positions as legislators, senior officials and managers: 61.0%
Percentage share of professional and technical positions: 64.7%	Percentage share of professional and technical positions: 35.3%

EDEP for positions as legislators, senior officials and managers = $\{[0.536\ (39.0^{-1})] + [0.464\ (61.0^{-1})]\}^{-1} = 46.85$

$$\text{Indexed EDEP for positions as legislators, senior officials and managers} = \frac{46.85}{50} = 0.937$$

EDEP for professional and technical positions = $\{[0,536\ (64,7^{-1})] + [0,464\ (35,3^{-1})]\}^{-1} = 46,67$

$$\text{Indexed EDEP for professional and technical positions} = \frac{46.67}{50} = 0.933$$

The two indexed EDEPs are averaged to create the EDEP for economic participation:

$$\text{EDEP for economic participation} = \frac{0.937 + 0.933}{2} = \mathbf{0.935}$$

3. Calculating the EDEP for income

Earned income (PPP US$) is estimated for women and men separately and then indexed to the scaled goalposts as was done for the GDI (for details, see the addendum to this technical note.). For the GEM, however, the income index is based on unadjusted values, not the logarithm of estimated earned income.

FEMALE
Population share: 0.536
Estimated earned income (PPP US$): 8,476

$$\text{Income index} = \frac{8{,}476 - 100}{40{,}000 - 100} = 0{,}210$$

MALE
Population share: 0.464
Estimated earned income (PPP US$): 13,581

$$\text{Income index} = \frac{13{,}581 - 100}{40{,}000 - 100} = 0{,}338$$

The female and male indices are then combined to create the equally distributed index:

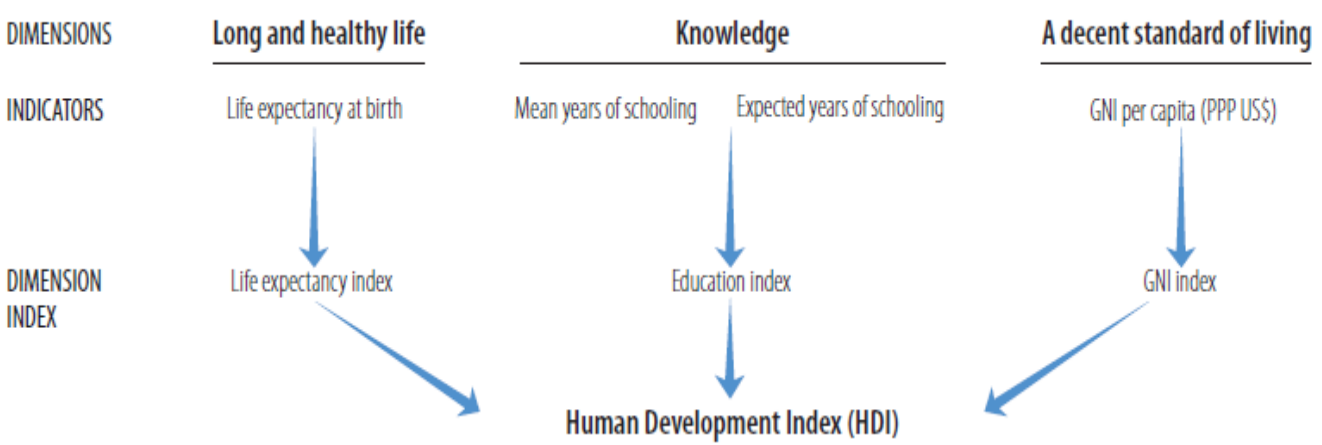
$$\text{EDEP for income} = \{[0.536\,(0.210^{-1})] + [0.464\,(0.338^{-1})]\}^{-1} = \mathbf{0.255}$$

4. Calculating the GEM

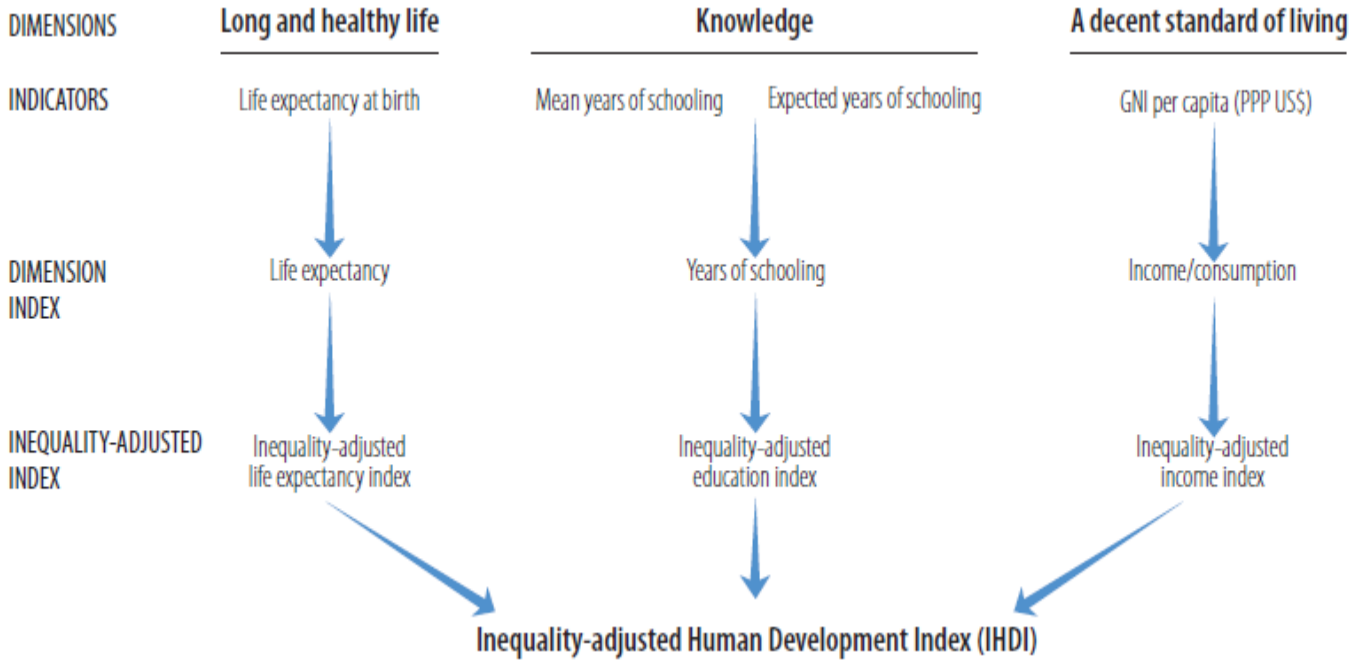
Once the EDEP has been calculated for the three dimensions of the GEM, determining the GEM is straightforward. It is a simple average of the three EDEP indices.

$$\text{GEM} = \frac{0.278 + 0.935 + 0.255}{3} = \mathbf{0.489}$$

Human Development Index (HDI)



Inequality-adjusted Human Development Index (IHDI)



Inequality-adjusted Human Development Index

- The Inequality-adjusted Human Development Index (IHDI) adjusts the Human Development Index (HDI) for inequality in distribution of each dimension across the population. It is based on a distribution-sensitive class of composite indices proposed by Foster, Lopez-Calva, and Szekely (2005), which draws on the Atkinson (1970) family of inequality measures.
- It is computed as a geometric mean of geometric means, calculated across the population for each dimension separately.
- The IHDI accounts for inequalities in HDI dimensions by "discounting" each dimension's average value according to its level of inequality.

- The IHDI equals the HDI when there is no inequality across people but is less than the HDI as inequality rises. In this sense, the IHDI is the actual level of human development (accounting for this inequality), while the HDI can be viewed as an index of "potential" human development (or the maximum level of HDI) that could be achieved if there was no inequality.
- The "loss" in potential human development due to inequality is given by the difference between the HDI and the IHDI and can be expressed as a percentage.

Step 1. Measuring inequality in underlying distributions

- There are three steps to computing the IHDI.
- The IHDI draws on the Atkinson (1970) family of inequality measures and sets the aversion parameter ε equal to 1.
- The inequality aversion parameter guides the degree to which lower achievements are emphasized and higher achievements are de-emphasized
- In this case the inequality measure is A = 1– g/μ, where g is the geometric mean and μ is the arithmetic mean of the distribution.
- This can be written as:

$$A_x = 1 - \frac{\sqrt[n]{X_1 \ldots X_n}}{\bar{X}}$$

- Where $\{X_1,\ldots, X_n\}$ denotes the underlying distribution in the dimensions of interest. A_x *is obtained for each variable* (life expectancy, years of schooling and disposable income or consumption per capita) using household survey data and the life tables.

A_x is estimated from survey data using the survey weights,

$$\hat{A}_x = 1 - \frac{X_1^{w_1} \ldots X_n^{w_n}}{\sum_1^n w_i X_i}, \text{ where } \sum_1^n w_i = 1.$$

- The geometric mean in the A_x does not allow zero values. For mean years of schooling one year is added to all valid observations to compute the inequality.
- Income per capita outliers-extremely high incomes as well as negative and zero incomes-were dealt with by truncating the top 0.5 percentile of the distribution to reduce the influence of extremely high incomes and by replacing the negative and zero incomes with the minimum value of the bottom 0.5 percentile of the distribution of positive incomes.

Step 2. Adjusting the dimension indices for inequality

- The mean achievement in a dimension, $\bar{X}$, *is adjusted for* inequality as follows:

$$\bar{X}^* = \bar{X}(1 - A_x) = \sqrt[n]{X_1 \ldots X_n}$$

Thus $\bar{X}^*$, the geometric mean of the distribution, reduces the mean according to the inequality in distribution, emphasizing the lower end of the distribution.

The inequality-adjusted dimension indices, I_{I_X}, are obtained from the HDI dimension indices, I_X, by multiplying them by $(1 - A_x)$, where A_x is the corresponding Atkinson measure:

$$I_{I_X} = (1 - A_x) \cdot I_X .$$

The inequality-adjusted income index, $I^*_{I_{Income}}$, is based on the unlogged gross national income (GNI) index, I^*_{Income}. This enables the IHDI to account for the full effect of income inequality.

Step 3. Computing the Inequality-adjusted Human Development Index

The IHDI is the geometric mean of the three dimension indices adjusted for inequality. First, the IHDI that includes the unlogged income index (IHDI*) is calculated:

$$IHDI^* = \sqrt[3]{I_{I_{Life}} \cdot I_{I_{Education}} \cdot I^*_{I_{Income}}} =$$

$$\sqrt[3]{(1-A_{Life}) \cdot I_{Life} \cdot (1-A_{Education}) \cdot I_{Education} \cdot (1-A_{Income}) \cdot I^*_{Income}}.$$

The HDI based on unlogged income index (HDI^*) is then calculated. This is the value that $IHDI^*$ would take if all achievements were distributed equally:

$$HDI^* = \sqrt[3]{I_{I_{Life}} \cdot I_{I_{Education}} \cdot I^*_{I_{Income}}}.$$

The percentage loss to the HDI^* due to inequalities in each dimension is calculated as:

$$Loss = 1 - \frac{IHDI^*}{HDI^*} = 1 - \sqrt[3]{(1-A_{Life}) \cdot (1-A_{Education}) \cdot (1-A_{Income})}.$$

Assuming that the percentage loss due to inequality in income distribution is the same for both average income and its logarithm, the IHDI is then calculated as:

$$IHDI = \left(\frac{IHDI^*}{HDI^*}\right) \cdot HDI$$

which is equivalent to

$$IHDI = \sqrt[3]{(1-A_{Life}) \cdot (1-A_{Education}) \cdot (1-A_{Income})} \cdot HDI.$$

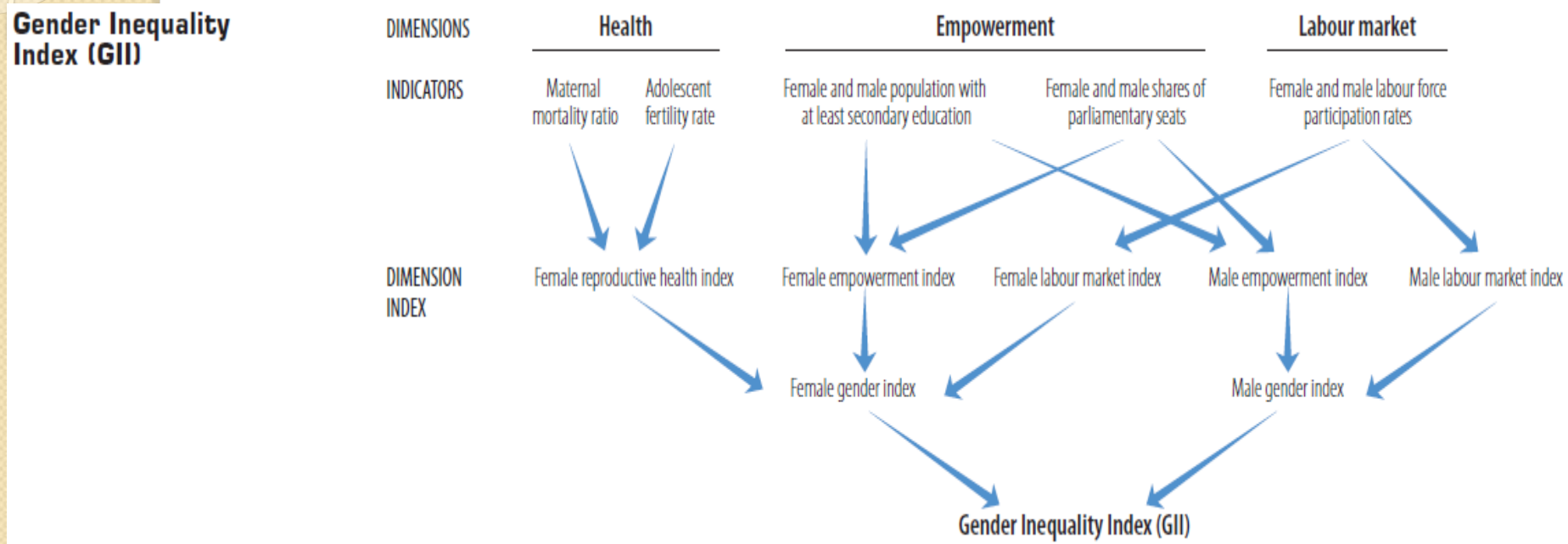
Example: Slovenia

	Indicator	Dimension index	Inequality measure (A1)	Inequality-adjusted index
Life expectancy	78.8	0.930	0.043	(1–0.043) · 0.930 = 0.890
Mean years of schooling	9	0.682		
Expected years of schooling	16.7	0.811		
Education index		0.782	0.040	(1–0.040) · 0.782 = 0.751
Logarithm of GNI	10.16	0.780		
GNI	25,857	0.238	0.122	(1–0.122) · 0.238 = 0.209

	Human Development Index	Inequality-adjusted Human Development Index	Percent loss
HDI with unlogged income	$\sqrt[3]{0.930 \cdot 0.782 \cdot 0.238} = 0.557$	$\sqrt[3]{0.890 \cdot 0.751 \cdot 0.209} = 0.519$	1–0.519/0.557 = 0.068
HDI	$\sqrt[3]{0.930 \cdot 0.782 \cdot 0.780} = 0.828$	(0.519 / 0.557) · 0.828 = 0.772	

Note: Values are rounded.

Calculating the Gender Inequality Index



- The Gender Inequality Index (GII) reflects women's disadvantage in three dimensions-reproductive health, empowerment and the labour market. The index shows the loss in human development due to inequality between female and male achievements in these dimensions. It ranges from 0, which indicates that women and men fare equally, to 1, which indicates that women fare as poorly as possible in all measured dimensions.

There are five steps to computing the GII.

Step 1. Treating zeros and extreme values

- The maternal mortality ratio is truncated symmetrically at 10 (minimum) and at 1,000 (maximum). The maximum of 1,000 is based on the normative assumption that countries where the maternal mortality ratio exceeds 1,000 are not different in their ability to create conditions and support for maternal health. Similarly, it is assumed that countries with 1–10 deaths per 100,000 births are essentially performing at the same level.
- The female parliamentary representation of countries reporting 0 percent is coded as 0.1 percent because the geometric mean cannot have zero values and because these countries do have some kind of political influence by women.

Step 2. Aggregating across dimensions within each gender group, using geometric means

Aggregating across dimensions for each gender group by the geometric mean makes the GII association sensitive (see Seth 2009).

For women and girls, the aggregation formula is

$$G_F = \sqrt[3]{\left(\frac{1}{MMR} \cdot \frac{1}{AFR}\right)^{1/2} \cdot (PR_F \cdot SE_F)^{1/2} \cdot LFPR_F},$$

and for men and boys the formula is

$$G_M = \sqrt[3]{1 \cdot (PR_M \cdot SE_M)^{1/2} \cdot LFPR_M}.$$

Step 3. Aggregating across gender groups, using a harmonic mean

The female and male indices are aggregated by the harmonic mean to create the equally distributed gender index

$$HARM(G_F, G_M) = \left[\frac{(G_F)^{-1} + (G_M)^{-1}}{2}\right]^{-1}.$$

Using the harmonic mean of geometric means within groups captures the inequality between women and men and adjusts for association between dimensions.

Step 4. Calculating the geometric mean of the arithmetic means for each indicator

The reference standard for computing inequality is obtained by aggregating female and male indices using equal weights (thus treating the genders equally) and then aggregating the indices across dimensions:

$$G_{F,M} = \sqrt[3]{\overline{Health} \cdot \overline{Empowerment} \cdot \overline{LFPR}}$$

where $\overline{Health} = \left(\sqrt{\frac{1}{MMR} \cdot \frac{1}{AFR}} + 1 \right) /2,$

$$\overline{Empowerment} = \left(\sqrt{PR_F \cdot SE_F} + \sqrt{PR_M \cdot SE_M} \right) /2 \text{ and}$$

$$\overline{LFPR} = \frac{LFPR_F + LFPR_M}{2}.$$

$\overline{Health}$ should not be interpreted as an average of corresponding female and male indices but as half the distance from the norms established for the reproductive health indicators—fewer maternal deaths and fewer adolescent pregnancies.

Step 5. Calculating the Gender Inequality Index

Comparing the equally distributed gender index to the reference standard yields the GII,

$$1 - \frac{Harm\,(G_F, G_M)}{G_{F,M}}.$$

Example: Brazil

	Reproductive health		Empowerment		Labour market
	Maternal mortality ratio	Adolescent fertility rate	Parliamentary representation	Attainment at secondary and higher education	Labour market participation rate
Female	110	75.6	0.094	0.488	0.640
Male	na	na	0.906	0.463	0.852
(F+M)/2	$\left(\sqrt{(1/110)\cdot(1/75.6)}+1\right)/2=0.50$		$\left(\sqrt{0.094\cdot 0.488}+\sqrt{0.906\cdot 0.463}\right)/2=0.431$		$(0.640+0.852)/2=0.746$

na is not applicable.

Using the above formulas, it is straightforward to obtain:

$$G_F \quad 0.115=\sqrt[3]{\sqrt{\left(\frac{1}{110}\cdot\frac{1}{75.6}\right)}\cdot\sqrt{0.094\cdot 0.488}\cdot 0.640}$$

$$G_M \quad 0.820=\sqrt[3]{1\cdot\sqrt{0.906\cdot 0.463}\cdot 0.852}$$

$$Harm\,(G_F, G_M) \quad 0.201=\left[\frac{1}{2}\left(\frac{1}{0.115}+\frac{1}{0.820}\right)\right]^{-1}$$

$$G_{F,M} \quad 0.546=\sqrt[3]{0.505\cdot 0.431\cdot 0.746}$$

$$\text{GII} \quad 1-0.201/0.546=0.632.$$

National HDR

HDI and GEI — Departures from UNDP Indices

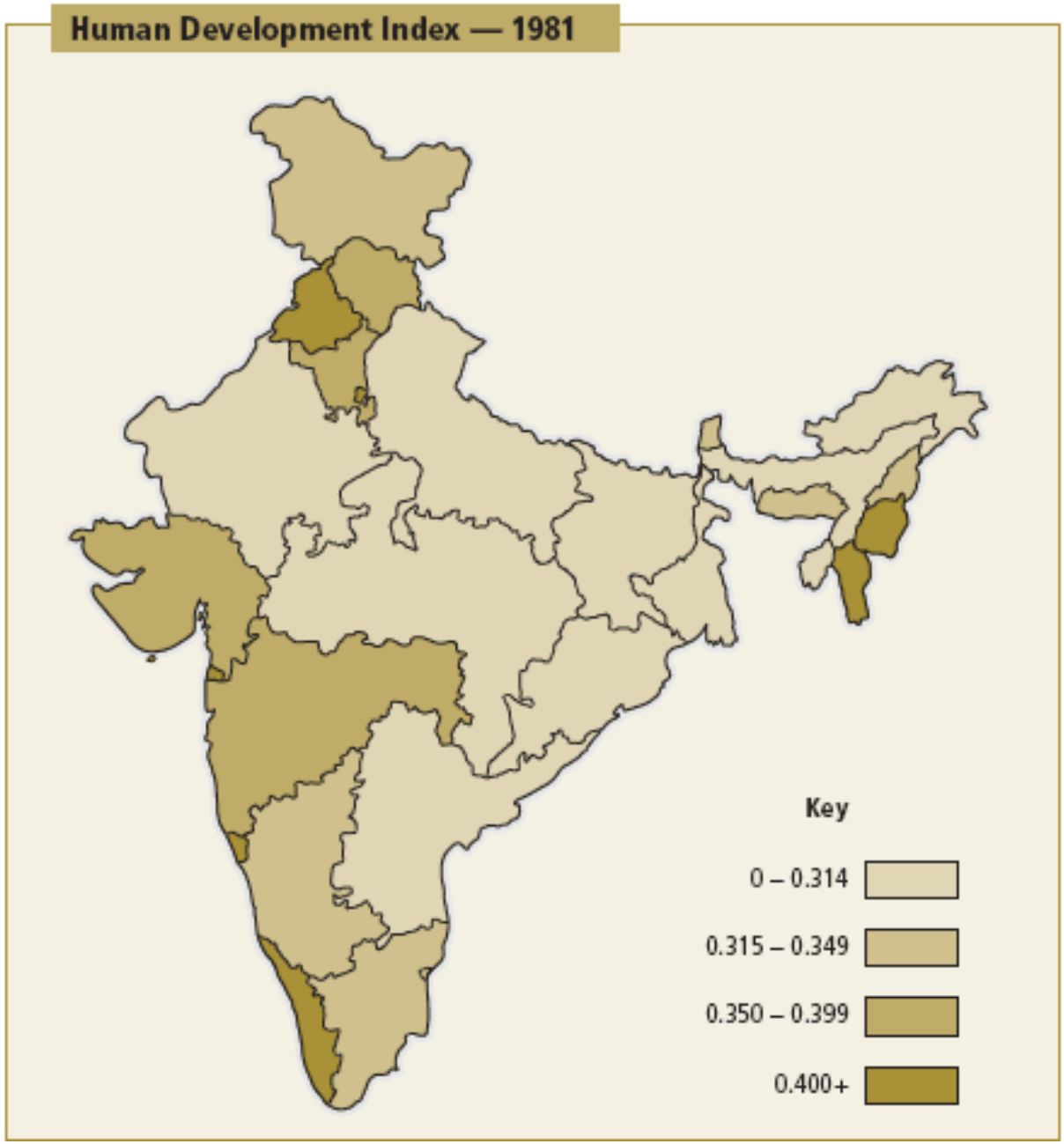
UNDP-Indicators	Attainments	NHDR-Indicators
Life Expectancy at Birth	Longevity	Life Expectancy at age 1 and Infant Mortality Rate
Adult Literacy Rate combined with Enrolment ratio	Educational Attainment	Literacy Rate 7+ and Intensity of Formal Education
Real GDP Per Capita in PPP$	Economic Attainment	Per capita real consumption expenditure adjusted for inequality; Worker-population ratio in case of Gender Equality Index

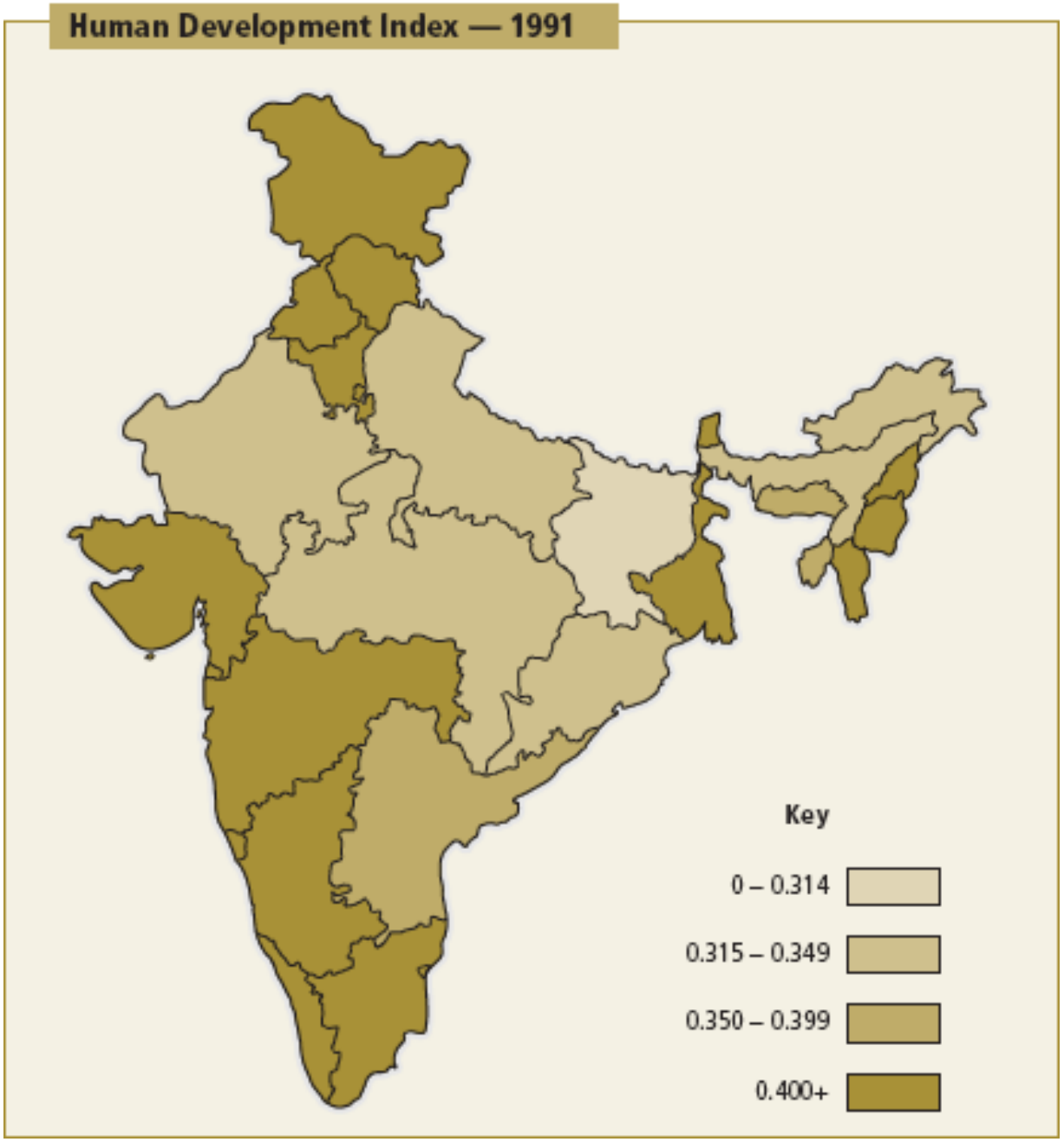
Human Development Index for India — Combined

States/UTs	1981 Value	1981 Rank	1991 Value	1991 Rank	2001 Value	2001 Rank
Andhra Pradesh	0.298	9	0.377	9	0.416	10
Assam	0.272	10	0.348	10	0.386	14
Bihar	0.237	15	0.308	15	0.367	15
Gujarat	0.360	4	0.431	6	0.479	6
Haryana	0.360	5	0.443	5	0.509	5
Karnataka	0.346	6	0.412	7	0.478	7
Kerala	0.500	1	0.591	1	0.638	1
Madhya Pradesh	0.245	14	0.328	13	0.394	12
Maharashtra	0.363	3	0.452	4	0.523	4
Orissa	0.267	11	0.345	12	0.404	11
Punjab	0.411	2	0.475	2	0.537	2
Rajasthan	0.256	12	0.347	11	0.424	9
Tamil Nadu	0.343	7	0.466	3	0.531	3
Uttar Pradesh	0.255	13	0.314	14	0.388	13
West Bengal	0.305	8	0.404	8	0.472	8
All India	**0.302**		**0.381**		**0.472**	

Note *The HDI for 2001 has been estimated only for a few selected States for which some data, including the Census 2001, was available. The assumptions that have been made for HDI 2001 are indicated in the Technical Appendix.*

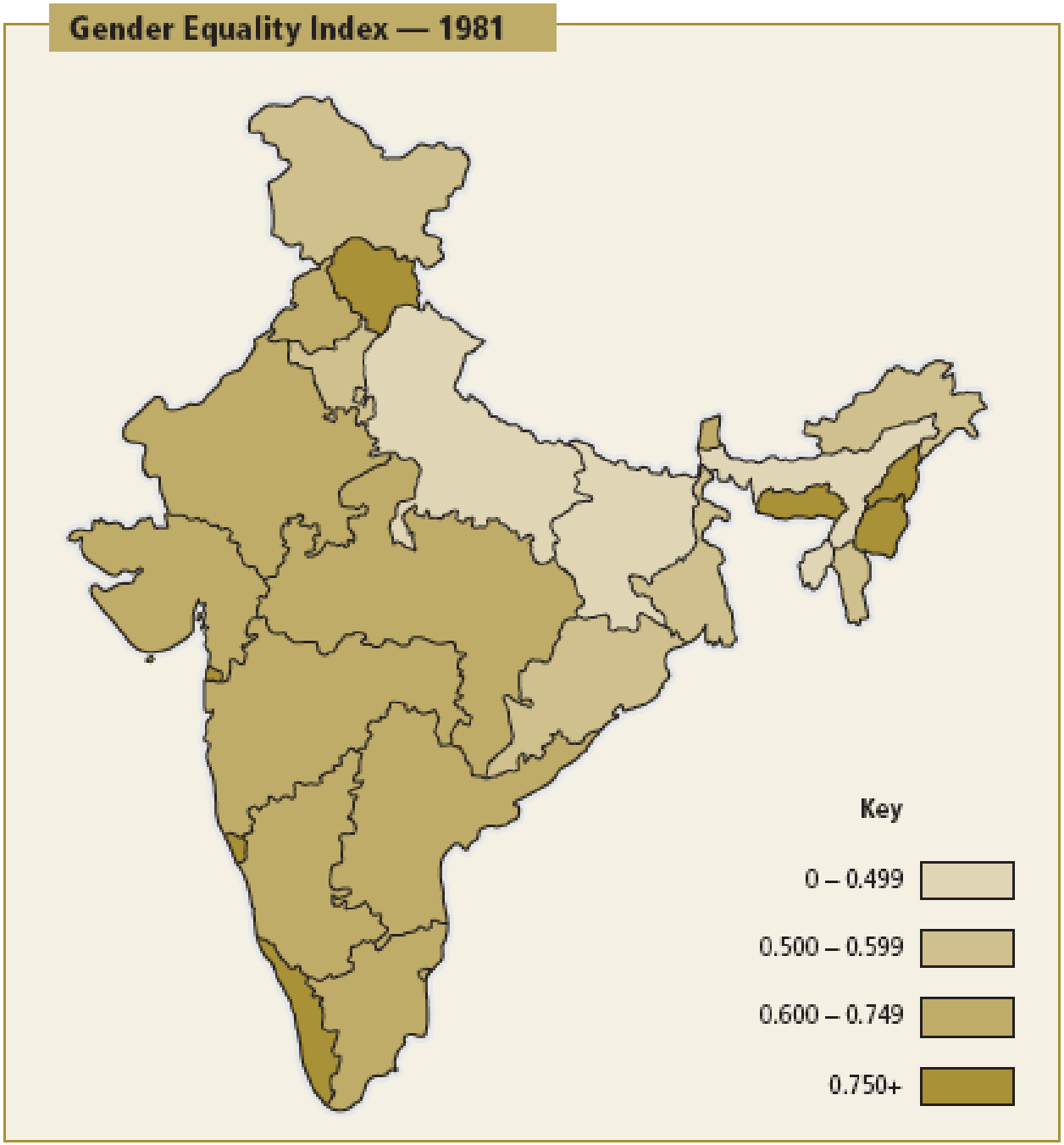
- The HDI has been estimated for all the States/Union Territories, separately for rural and urban areas, for early eighties, using data covering the period 1981 to 1983; for the early nineties, covering the period 1991 to 1993-94; and in case of selected major States for the year 2001, using data for the period 1999-2001.
- At the national level, HDI, which takes a value between 0 and 1, has improved from 0.302 in 1981 to 0.381 in 1991.
- The improvement for rural areas is from 0.263 to 0.340 and in case of urban areas, from 0.442 to 0.511.
- Though the rural-urban gap continues to be significant, it has declined.
- The ratio of urban to rural HDI has declined from around 1.7 in early eighties to 1.5 in early nineties.

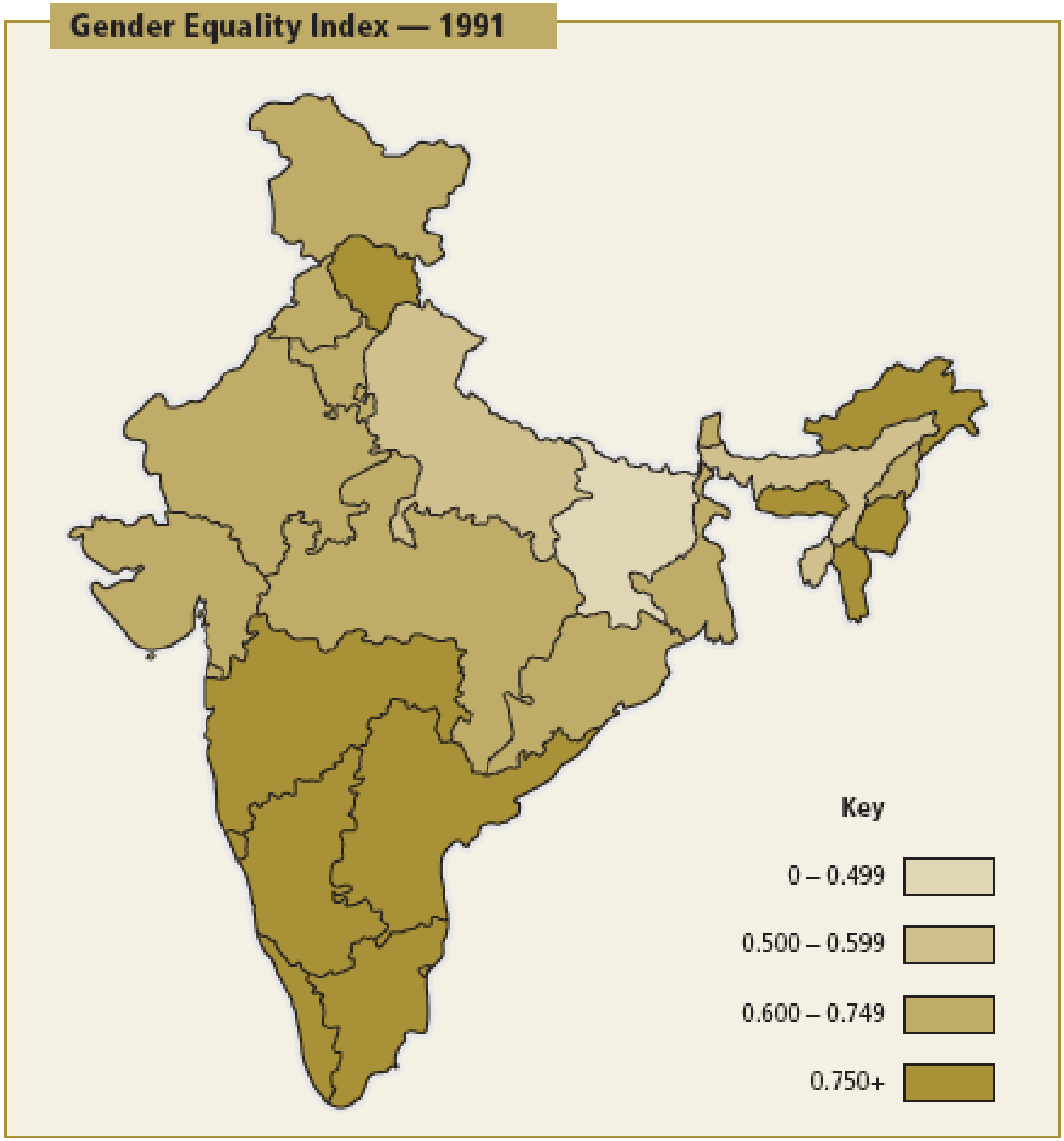

Human Development Index — 1981
Key
0 – 0.314
0.315 – 0.349
0.350 – 0.399
0.400+


Human Development Index — 1991
Key
0 – 0.314
0.315 – 0.349
0.350 – 0.399
0.400+

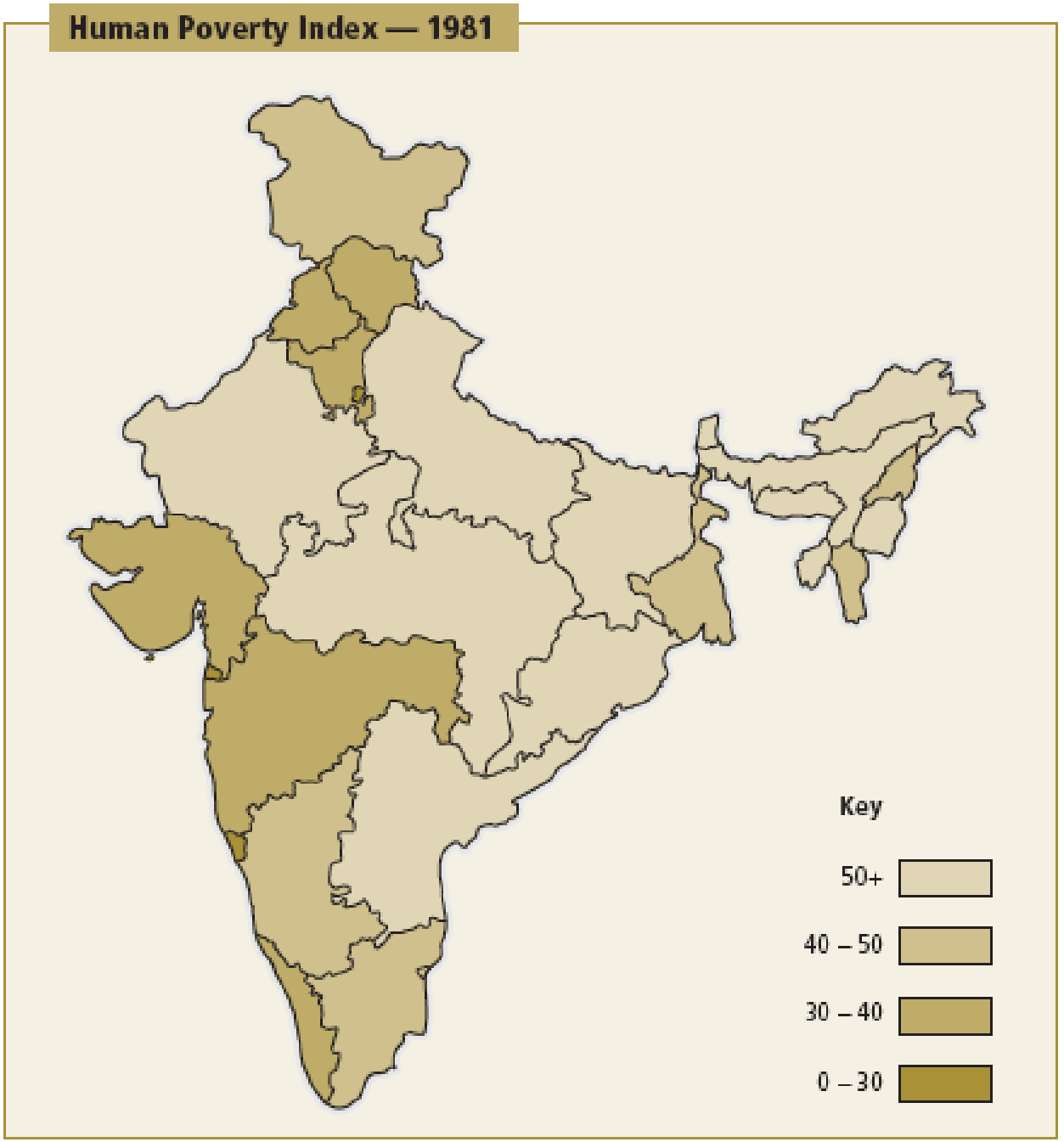
- GEI has been estimated to measure the inequality in attainments on human development indicators between females and males.
- The index has been presented as a ratio of attainments for females to that of males.
- Theoretically, the index can take values between zero and infinity, with a value of unity reflecting an absolute equality in the respective attainments of males and females. A value higher than unity would imply that females have better attainments than males.
- However, in reality, the index is likely to take a value between zero and unity.

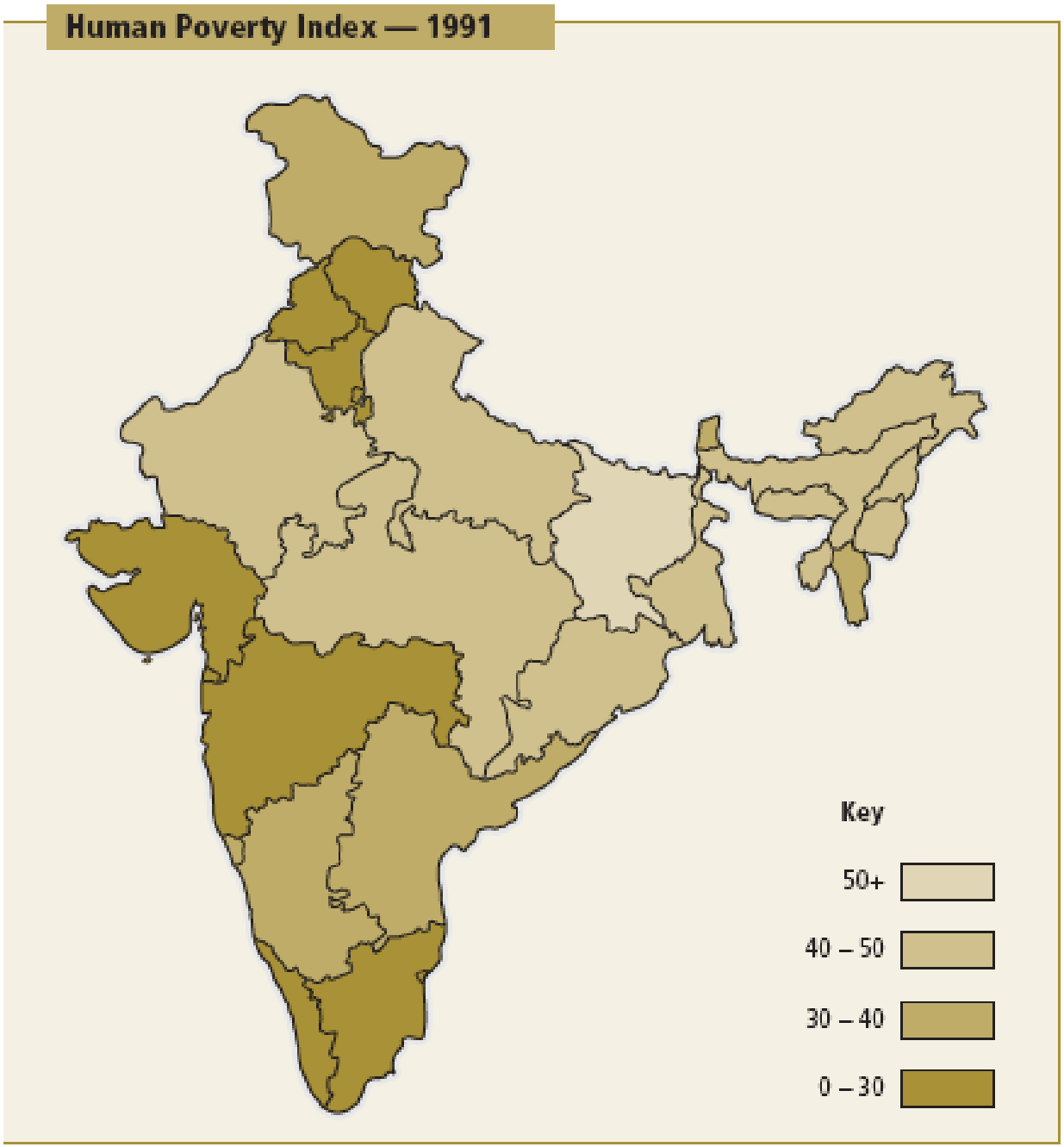
- In estimating the index, the economic attainments for males and females have been captured by taking the respective worker population ratio, unlike the use of per capita monthly expenditure in the HDI.
- This has been done, primarily, to avoid taking recourse to apportioning consumption or income, between males and females at the household or at an individual level, using criteria that could always be debated.
- Moreover, worker population ratio, particularly for females in a developing society like India is, in some sense, a direct measure of the extent of empowerment that females have in a society.
- Educational and health attainments have been captured using the same set of indicators as in the case of HDI.


Gender Equality Index — 1981
Key
0 – 0.499
0.500 – 0.599
0.600 – 0.749
0.750+


Gender Equality Index — 1991
Key
0 – 0.499
0.500 – 0.599
0.600 – 0.749
0.750+

- The GEI, at the national level, was 0.620 in the early eighties, improving marginally to 0.676 in the early nineties.
- At the State level, GEI was the highest for Kerala followed by Manipur, Meghalaya, Himachal Pradesh and Nagaland in the eighties.
- In the nineties, Himachal Pradesh had the highest GEI, whereas Bihar was at the bottom and had witnessed a decline, in absolute terms, over the earlier period.
- In general, women were better off in Southern India than in the Indo-Gangetic plain, comprising mainly the States of Bihar and Uttar Pradesh.


Human Poverty Index — 1981
Key
50+
40 – 50
30 – 40
0 – 30


Human Poverty Index — 1991
Key
50+
40 – 50
30 – 40
0 – 30

HPI

- The HPI has been estimated to reflect the deprivational perspective on development. Indicators on three aspects of deprivation have been considered to construct the composite index.
- Deprivation in health and longevity was captured essentially through the proportion of the population not expected to survive to age 40 years. In addition, proportion of population without access to basic medical services; proportion of deliveries not receiving medical attention; and proportion of children not immunized; were also included to reflect deprivation in health attainments.

- Educational deprivation has been captured through illiteracy rates and children in the school going age group not enrolled in schools.
- For capturing economic deprivation, proportion of population below a poverty line anchored in a food-adequacy norm; proportion of the population living in *kutcha* houses; proportion of population without access to sanitation; proportion of population without access to safe drinking water; and proportion of population without electricity, have been used.
- While each of the three dimensions of deprivation, namely, educational, health and economic wellbeing have been given a one-third weight in the composite index, for each of the dimension, the composite measure has been estimated as an average of the relevant indicators.

- The HPI takes value between 0 and 100 such that a higher deprivation for a State means a value closer to 100. In this case, it would imply that the entire population of the State is deprived of even the minimal attainments on each of the three dimensions.
- At the national level, the proportion of the deprived on the HPI was 47.33 per cent in the early eighties. The proportion was significantly higher for rural areas at about 53 per cent, as against about 27 per cent in urban areas.
- It declined to 39.36 per cent in the early nineties on the comparable HPI, and was a little less on the alternate HPI (with some changes in the included indicators) at 37.42 per cent.

- The HPI for rural areas, on the comparable index, was about 45 per cent and was less than half at 22 per cent in case of urban areas. Thus, the decline in the rural areas was a litter higher than the decline in urban areas, resulting in a marginal decline in the rural-urban gap.
- The inter-State differences in the HPI are quite striking. It was in the range of 55-60 per cent in the early eighties for the worse off States, namely, Orissa, Bihar, Arunachal Pradesh, Assam and Uttar Pradesh, and between 32-35 per cent in the better off States like Kerala, Punjab and Himachal Pradesh.
- It was only in the smaller, predominantly, urban areas of Delhi and Chandigarh that had an HPI in the range of 17-20 per cent. The value of HPI in early nineties had declined in all the States.