

# Visualize Inequality:

## Inequality of Opportunities in Sub-Saharan Africa

### Overview

Imagine a country where your future did not depend on where you come from, how much your family earns, or whether you are male or female. Imagine if personal circumstances, those over which you have no control or responsibility, were irrelevant to you and your children's opportunities. And imagine now a statistical tool that can help governments make that a reality. That tool is the Human Opportunity Index.

The Human Opportunity Index calculates how personal circumstances (like area of residence, wealth or gender) impact a child's probability of accessing the services that are necessary to succeed in life, like education, running water or connection to electricity. With *Visualize Inequality*, the World Bank Group makes available to policy makers, governments, researchers, journalists and the broad audience, the results from several exercises on access to basic opportunities for children.

This documentation file covers the basic aspects of the Human Opportunity Index methodology (section 1), which are not addressed on the individual dashboards. It also presents the data sources (section 2).

### 1. The Human Opportunity Index

The Human Opportunity Index measures the availability of services that are necessary to progress in life (say, running water), discounted by how unfairly the services are distributed among the population. In other words, the Human Opportunity Index is coverage corrected for inequality.

Imagine any country and a basic opportunity: access to clean water. If 70 out of 100 children access to this service then 70% (that is  $\frac{70}{100}$ ) of children have access to this opportunity –the national coverage rate. Now imagine that 60 of these kids live in urban areas while 40 live in rural areas. However, while the rate of coverage for this basic service is 90% in urban areas, it is 40% in rural areas. Thus

$$60\% \times 90\% + 40\% \times 40\% = 70\%.$$

We can build a measure of how unequal the access to water is distributed among groups by computing the absolute value of the difference between the national coverage rate and the group-level coverage rate multiplied by the share of that group in the population, and then adding them up. Therefore, for urban areas the dissimilarity would be

$$60\% \times |70\% - 90\%| = 12\%,$$

and for rural areas the dissimilarity would be

$$40\% \times |70\% - 40\%| = 20\%.$$

Now we proceed to compute our measure of inequality: the Inequality Index, which is the sum of all dissimilarities multiplied by a proportional factor, equal to 0.5 times one divided by the coverage rate. So, we proceed to discount the coverage rate by this measure of inequality:

$$70\% \times \left( 100\% - 0.5 \frac{(12\% + 20\%)}{70\%} \right).$$

The result of this operation is 54%, which is the Human Opportunity Index.

More generally, let  $C$  be the national coverage rate and  $C_k$  the coverage rate for group  $k$  defined by a set of circumstances (area of residence, gender, wealth, etc.)  $X = (X_1, X_2, \dots, X_n)$ , so that  $k \in X_1 \times X_2 \times \dots \times X_n$ . Therefore, the inequality index  $D$  can be defined as:

$$D = \frac{1}{2C} \sum_{k=1}^m \alpha_k |C - C_k|$$

and the Human Opportunity Index (HOI) would be given by

$$HOI = C(1 - D).^1$$

## 1.1. Inequality Contributors

For each exercise we used harmonized data sets, which allow comparability across countries and time within region; we also used a set of variables that might be considered exogenous to children (not under their control). However, given that the Human Opportunity Index is sensitive to the circumstances chosen for the analysis, we provide the user with information of the share of the inequality index that is explained by each circumstance. We compute the contribution of each circumstance to inequality by adding and subtracting circumstances from the calculations, so that we are able to determine how important is a given circumstance (for example, wealth) in each calculation. Then we take an average of these numbers to determine the contribution of each circumstance to inequality.

We use Shorrocks (1999) decomposition method to compute the contribution of each circumstance to the inequality index. More formally, consider  $D = D(X)$  the inequality index given the vector of circumstances  $X$ . If we have two sets of circumstances  $A, B \in X$ , and  $A \cap B = \emptyset$ ,  $D(A, B) \geq D(A)$ . Thus, the impact of adding a set of circumstances  $A$  is given by:

$$D_A = \sum_{S \subseteq N \setminus \{A\}} \frac{|s|!(n - |s| - 1)!}{n!} [D(S \cup \{A\}) - D(S)]$$

where  $N$  is the set of all circumstances, and  $n$  is the subset of variables;  $S$  is a subset of  $N$  (containing  $s$  circumstances) that does not contain  $A$ . And, thus, we can define the contribution of the set of variables  $A$  to the inequality index as  $M_A = \frac{D_A}{D(N)}$ , where  $\sum_{i \in N} M_i = 1$ .<sup>2</sup>

<sup>1</sup> For further methodological details we recommend reading Barros et al. (2009, 2010).

## 1.2. Changes in Human Opportunity

Suppose that you have data for two periods in time on access to any human opportunity. If between these two periods the level of coverage, for example, increased, then we may wonder about the specific source of the change: is it because coverage rose or because inequality declined? Or is it because the sample of kids changed (maybe due to changes in sampling) leading to an increase in the coverage rate?

If the level of coverage changed for all groups in the same level, this implies that

$$HOI_{2nd\ period} - HOI_{1st\ period} = C_{2nd\ period}(1 - D_{mix}) - C_{mix}(1 - D_{mix}),$$

where  $C_{mix} = E(C_{2nd\ period} | X_{1st\ period})$  and  $D_{mix} = E(D_{2nd\ period} | X_{1st\ period})$ .

On the other hand, it may be that the coverage changed for any underserved group ( $C_k < C$ ), then

$$HOI_{2nd\ period} - HOI_{1st\ period} = C_{2nd\ period}(1 - D_{2nd\ period}) - C_{2nd\ period}(1 - D_{mix}).$$

Finally, it may be that the Human Opportunity Index changed by a redistribution of the population itself, where the sizes of the circumstance groups change. Therefore

$$HOI_{2nd\ period} - HOI_{1st\ period} = C_{mix}(1 - D_{mix}) - C_{1st\ period}(1 - D_{1st\ period}).$$

In other words, let it be two periods  $t = \{1,2\}$ , then the change between  $t = 1$  and  $t = 2$  is given by

$$HOI_2 - HOI_1 =$$

$$\underbrace{[C_{mix}(1 - D_{mix}) - C_1(1 - D_1)]}_{\substack{\text{Scale effect} \\ \text{(changes for all)}}} + \underbrace{[C_2(1 - D_2) - C_2(1 - D_{mix})]}_{\substack{\text{Equalization effect} \\ \text{(changes for underserved group)}}} + \underbrace{[C_2(1 - D_{mix}) - C_{mix}(1 - D_{mix})]}_{\substack{\text{Composition effect} \\ \text{(residual change)}}}.$$

For more information we recommend consulting Barros et al. (2009).

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<sup>2</sup> For further methodological details we recommend reading Hoyos and Narayan (2011).

## Data Sources for the Sub-Saharan Africa Region:

The following table shows each of the data sources used by country:

Table 1. Data Sources

Country	Survey name	Circa 1998	Circa 2008
Cameroon	Demographic and Health Survey	1998	2004
Dem. Rep. Congo	Demographic and Health Survey		2007
Ethiopia	Demographic and Health Survey	2000	2011
Ghana	Demographic and Health Survey	1998	2008
Kenya	Demographic and Health Survey	1998	2008-09
Liberia	Demographic and Health Survey		2007
Madagascar	Demographic and Health Survey	1997	2008-09
Malawi	Demographic and Health Survey	2000	2010
Mali	Demographic and Health Survey	1995-96	2006
Mozambique	Demographic and Health Survey	1997	2003
Namibia	Demographic and Health Survey	2000	2006-07
Niger	Demographic and Health Survey	1998	2006
Nigeria	Demographic and Health Survey	1999	2008
Rwanda	Demographic and Health Survey	2000	2010
Senegal	Demographic and Health Survey	1997	2010-11
Sierra Leone	Demographic and Health Survey		2008
Tanzania	Demographic and Health Survey	1996	2010
Uganda	Demographic and Health Survey	1995	2006
Zambia	Demographic and Health Survey	1996	2007
Zimbabwe	Demographic and Health Survey	1994	2010-11

Source: Poverty Global Practice, Central Unit.

Table 2 shows the opportunities and circumstances used and how are they defined:

Table 2. Opportunities and Circumstances

### A. Opportunities

Dimension	Opportunity	Description
Education	Attend school (age 6-11)	Percentage of children 6 to 11 years of age attending to school at the time of the survey or that attended school during the year previous to the survey.
	Attend school (age 12-15)	Percentage of children 12 to 15 years of age attending to school at the time of the survey or that attended school during the year previous to the survey.
	Started primary on time	Percentage of children 6 to 7 years of age attending primary school (for 6 years-old) and having one or more years of education (for 7 years-old).
	Finished primary school	Percentage of children 12 to 15 years of age attending 6th grade (for 12 years-old) and completing 6 or more years of education (for 13-15 years-old).
Infrastructure	Have water	Percentage of children 0 to 16 years of age living in a household with access to piped, well or rain water.
	Have sanitation	Percentage of children 0 to 16 years of age living in a household with flush toilet or pit toilet
	Have electricity	Percentage of children 0 to 16 years of age living in a household with access to electricity.
Health	Fully immunized	Percentage of children immunized against measles, dpt, bcg and polio (for 1 year-olds).
	Not stunted	Percentage of children with height-for-age two standard deviations below the mean (for 0 to 2 years of age).

## B. Circumstances

Dimension	Education Opportunities	Infrastructure Opportunities	Health Opportunities
<b>Child Characteristics</b>	Gender	Gender	Gender Birth order
<b>Household Composition</b>	Number of children (0 to 15 years of age) in the household Presence of Elderly (65+ years of age) Presence of both parents in the household Both parents alive	Number of children (0 to 15 years of age) in the household Presence of Elderly (65+ years of age) Presence of both parents in the household Both parents alive	Number of siblings living in the household Presence of Elderly (65+ years) Mother lives with husband
<b>Location</b>	Area of residence (urban/rural)	Area of residence (urban/rural)	Area of residence (urban/rural)
<b>Household Head Characteristics</b>	Education of household head Age of household head Gender of household head	Education of household head Age of household head Gender of household head	Education of mother Age of mother
<b>Socioeconomic status</b>	Wealth quintiles	Wealth quintiles	Wealth quintiles

Note: The set of circumstances for Senegal in circa 1998 does not include education of the household head, Nigeria circa 1998 does not include wealth quintiles, and Kenya in circa 2008 does not include orphan status and presence of parents. The reason for the omission in all these cases is because the information is not available. The wealth quintiles are calculated basis of the DHS wealth index. Education of the household head is categorized as follows: a) 0 years (no education), b) 1 to 6 years of education completed, c) 7 to 12 years of education completed, d) 13 or more years of education completed. Age of the household head is categorized as follows: a) 15 to 29 years of age, b) 30 to 39 years of age, c) 40 to 49 years of age, d) 50 to 64 years of age, and e) 65 or more years of age.

Source: Poverty Global Practice, Central Unit.

## References

- Barros, R., F. Ferreira, J. Molinas Vega and J. Saavedra (2009). Measuring Inequality of Opportunities in Latin American and the Caribbean. The International Bank for Reconstruction and Development/The World Bank.
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- Hoyos, A. and A. Narayan. (2011). "Inequality of opportunities among children: how much does gender matter?" Background Paper for WDR 2012. Manuscript.
- Shorrocks A. F. (1999), Decomposition Procedures for Distributional Analysis: A Unified Framework Based on the Shapley Value, Mimeo, University of Essex.