# mpitb: A toolbox for calculating multidimensional poverty indices in R

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**Abstract** This article presents **mpitb**, an R package for calculating multidimensional poverty indices (MPIs) based on the popular Alkire-Foster (AF) measurement approach. **mpitb** package provides a tractable and extensive framework for researchers, analysts, and practitioners working on mutltidimensional poverty measurement projects in the same vein of the well-known global MPI workflow. The toolbox mainly consists of providing methods for estimating AF measures such that they can be easily manipulated. In this way, users can concentrate on the very analysis of results. Furthermore, this package accounts for the complex survey design of micro data which is of key relevance in statistical inference of the estimates. A demonstration about the usage of **mpitb** package with a synthetic data which has a typical household survey design.

## Introduction

Although poverty is widely understood as the inability to basic living standards multidimensional well-being status, the measurement of poverty has traditionally been based on monetary deficits. Over the past two decades, there has been a significant increase in the use of multidimensional approaches to measuring poverty in an attempt to capture the complexity of this phenomenon. In this context, the dual-cut-off-counting measurement approach proposed by Alkire and Foster (2011) (AF, hereafter) has become particularly popular due to its flexibility and ability to inform policy. For example, the AF method is the basis of the global Multidimensional Poverty Index (MPI) which is yearly published by the United Nations Development Programme (UNDP) and the Oxford Poverty and Human Development Initiative (OPHI) (UNDP and OPHI 2022). In addition, many countries are developing their own official MPIs to track poverty reduction progress using the AF method.

This measurement approach stands out both for providing an extensive policy information platform and remaining relatively understandable by the general public. In other words, AF measures point estimates entail simple algebraic operations. Some R packages that computes AF measures include MPI (Kukiattikun and Chainarong 2022) and mpindex (Abdulsamad 2023). Notwithstanding, these packages do not account for the complex survey design of micro data and, as a result, assume the data was obtained through a simple random sampling. Rarely is this the case of household surveys. Not considering the complex survey design affects further statistical inference exercises of interest. Namely, is multidimensional poverty in one subgroup of the population greater than another? Has poverty been reduced over time?

Therefore, calculating AF measures in practice is still a challenging task. For this reason OPHI launched a Stata package mpitb with the aim of providing a integrated framework that mirrors the estimation process of the well-known global MPI to researchers, analysts and practitioners (Suppa 2023). In a nutshell, this package provides a set of subcommands for estimating key quantities. Not only AF measures but also their standard errors (considering sampling design) and confidence intervals. These quantities are not usually reported in poverty studies, however, they are for statistical inference. Thus, users can focus on the analysis of results.

With the aim of adapting this framework for R users, I developed the mpitb package. (continue)

The remainder of this paper is organized as follows. (continue)

## Measuring multidimensional poverty: the Alkire-Foster Method

Alkire and Foster (2011) proposed a flexible approach to measure multidimensional poverty that can be tailored to different contexts and policy purposes. The flexibility of this method mainly derived from the so-called "dual cutoff counting approach" for identifying the poor and the possibility to build the MPI by aggregating different partial measures. Building an MPI based on the AF approach can be summarized in the following steps (for a detailed description, see Alkire et al. 2015).

1. Determine a set of dimensions of poverty $\mathcal{D}$ that are considered relevant for human development in a specific context (e.g., the global MPI chooses dimensions of health, education, and living standards, but other dimensions can be chosen depending on the context and goals).

2. Select $d$ indicators that represents deprivations in each dimension (e.g., child mortality and malnutrition are the two indicators that represents health dimension in the global MPI).

3. Assign weights to each dimension and indicator, reflecting their relative importance where $w_j$ is represents the weight of the $j$-th indicator for $j = 1, \ldots, d$. In practice, indicators in each dimension are weighted equally such that $\sum_{j=1}^{d} w_j = 1$.

4. Set the indicators deprivation cutoffs, which define the minimum level of achievement required to be considered non-deprived in each indicator (e.g., the global MPI uses cutoffs of having at least five years of schooling, having access to electricity, etc., but different thresholds can be set reflecting desired standards).

5. Apply the deprivations cutoff vector to each of the $n$ observations (individuals or households) and build the $n \times d$ deprivation matrix $\mathbf{g^0}$. Each element $\left[\mathbf{g^0}_{ij}\right]$ of this matrix is a binary variable. If $\left[\mathbf{g^0}_{ij}\right] = 1$, the $i$-th observation is deprived in indicator $j$, and the opposite if $\left[\mathbf{g^0}_{ij}\right] = 0$.

6. Build the weighted deprivation matrix assigning the corresponding weight to each indicator and calculate the deprivations score for each observation $c_i$, which is the weighted sum of the deprivations $c_i = \sum_{j=1}^{d} w_j d_i j$.

7. Identify who is poor by setting a unique poverty cutoff $k$ meaning the minimum proportion of weighted deprivations a household needs to experience to be considered multidimensional poor. This cutoff is compared with the deprivations score. Therefore, if $c_i \geq k$, the person is multidimensional poor (e.g., the global MPI uses a cutoff $k$ of 33.3% or 1/3 which means that a person is poor if it is deprived in one-third or more of the weighted indicators).

8. Censor data of the non-poor and get the so-called censored (weighted) deprivation matrix $(\bar{\mathbf{g}}^0(k))$, and censored deprivations scores $(c(k))$, where $c_i(k) = c_i$ if $c_i \geq k$, and $c_i(k) = 0$ otherwise.

9. Compute the MPI $(M_0)$ by taking the mean of the censored deprivation score $(c(k))$:

$$M_0 = \frac{1}{n} \sum_{i=1}^{n} c_i(k)$$

As mentioned above, it is possible to obtain a set of policy-relevant partial measures, i.e., the MPI can be re-expressed as function of other measures. For instance,

- From the latter expression, by multiplying and dividing by the number of people identified as poor $(q)$

$$M_0 = \frac{q}{n} \times \frac{1}{q} \sum_{i=1}^{n} c_i(k) = H \times A$$

we obtained the intensity $(H)$ and intensity $(A)$ of poverty. The former is the proportion of multidimensional poor people while the latter are the average weighted deprivations suffered by the poor.

- From the censored deprivation matrix $\mathbf{g^0}(\mathbf{k})$, if we take the mean of each column, we obtain the censored indicators headcount ratios $h_j(k)$ which mean the proportion of people deprived in indicator $j$ *and* are multidimensional poor for $j, \ldots, d$. From these measures we can also arrive to the MPI:

$$M_0 = \sum_{j=1}^{d} w_j h_j(k)$$

Naturally, we can obtain the uncensored indicators headcount ratios $h_j$ before censoring the non-poor from data $\mathbf{g^0}(k)$.

- Also we can decompose not only the MPI but also every partial measure $(H, A, h_j, h_j(k))$ by different population subgroups (age, regions, etc.).

$$M_0 = \sum_{l=1}^{L} \phi^l M_0^l$$

where $\phi^l$ is the population share of the $l$-th subgroup for $l = 1, \ldots, L$.

Finally, the absolute $w_j h_j(k)$ and relative $w_j h_j(k) / M_0$ contribution of each indicator to poverty are usually reported.

## Overview of mpitb package

**mpitb** is a packages for . . .

## Applications

Suppa (2023) provide a set of examples on a synthetic data set following a common household survey structure. With the view of consistency, all applied examples here below are based on the same data.

### Estimate AF measures for a single county

```
library(mpitb)

data <- syn_cdta

data <- subset(data, t == 1)
```

## Summary

In this paper, we introduced a package for calculating multidimensional poverty indices based on the Alkire-Foster method

## Acknowledgements

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