AGRODEP Training Session

Multidimensional Poverty Measurement

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Introduction

- Multidimensional poverty measurement is at the heart of many institutional, theoretical and empirical debates
- Millenium Development Goals (MDG): define poverty as a multidimensional concept and focuson other dimensions than income

- Monetary poverty
- Education
- Gender Equality
- Health (maternal health, HIV, malaria and other disease, children mortality rate)
- Environment ans sustainability
- Hunger

Introduction

- "Poverty is a **denial of choices and opportunities**, a violation of human dignity. It means **lack of basic capacity to participate** effectively in society. It means not having enough to **feed** and **cloth** a family, not having a **school** or **clinic** to go to, not having the **land** on which to grow one's food or a **job** to earn one's living, not having access to **credit**. It means **insecurity, powerlessness and exclusion** of individuals, households and communities. It means susceptibility to **violence**, and it often implies living on marginal or fragile environments, **without access to clean water or sanitation**" (UN Statement, June 1998 – signed by the heads of all UN agencies).

Introduction

- "Poverty is **hunger.** Poverty is **lack of shelter**. Poverty is being **sick and not being able to see a doctor**. Poverty is **not having access to school** and **not knowing how to read**. Poverty is not having a **job**, is fear for the future, living one day at a time. Poverty is losing a **child to illness** brought about by unclean water. Poverty is **powerlessness, lack of representation and freedom**" (World Bank 2001 and 2005).

Theoretical foundations

- **Sen**'s capability approach (1981, 1985, 2000)
  - Complement to the too narrow utilitarian/monetary approach.
  - The objective function is increase people's freedom by increasing the set of possible "valuable beings and doings" (capability approach)
- **Basic human needs** (Streeten et al. [1981], Rawls [1971])
  - Provision of education, health, physical assets, access to goods and services are basic need to be fullfilled in any places.
  - All social primary goods - liberty and opportunity, income and wealth, and the bases of self-respect - are to be distributed equally unless an unequal distribution of any or all of these goods is to the advantage of the least favored.

Empirical debates

- There seems to be non consensus on how to define and measure multidimensional poverty
- This approach suffer from a lack of user-friendly operationalization method

Empirical debates

- What should we include in the multidimensional poverty measurement literature?
  - All approaches that takes into account non monetary information, in an *ad hoc* way (e.g. Townsend, 1979), including income or not.
  - Approaches that consider poverty as a polysemous concept with different definitions (e.g. lack of resources, subjective poverty, etc.) that constitute the different dimensions of poverty (Bradshaw and Finch, 2003)
  - Approaches that consider poverty as a continuum $=>$ provides an underlying model of multidimensional poverty (Fussco, 2006)

Key papers

- Anand S., Sen, A.K., 1997. Concepts of Human Development and Poverty. A multidimensional Perspectives. New York, UNDP.
- Tsui K., 2002. Multidimensional Poverty Indices. Social Choice and Welfare, vol 19, pp.69-93
- Atkinson AB., 2003. Multidimensional deprivation. Constrasting Social Welfare and Counting approaches. Journal of Economic Inequality
- Bourguignon F., Chakravarty S.R, 2003. The measurement of multidimensional Poverty. Journal of Economic Inequality. 1, 25-49.
- Alkire, S., Foster, J.E., 2011. "Counting and Multidimensional Poverty Measurement." Journal of Public Economics
- Alkire, S., Foster, J.E., 2011. Understandings and Misunderstandings of Multidimensional Poverty Measurement

Other Literature

- Axiomatic approaches
  - Key papers on the preceding slides
  - Kakwani, N., Silber, J., 2008. The Many Dimensions of Poverty. Palgrave MacMillan
  - Kakwani, N., Silber, J., 2008. Quantitative Approaches to Multidimensional Poverty Measurement. Palgrave Macmillan.
  - World Development, June 2008
- Counting literature
- Non-axiomatic approaches
  - Deutsch, J., Silber, J., 2005. Measuring Multidimensional Poverty. An Empirical Comparison of Various Approaches. The Review of Income and Wealth. 51, 145-174
  - Asselin, 2009. Analysis of Mutidimensional Poverty. IDRC/CRDI and Springer. New York.

Other ressources

- Very good online training portal and collection of references on Oxford Poverty and Human Development initiatives. http://www.ophi.org.uk/teaching/online-training-portal/
- PMMA project of PEP: http://www.pep-net.org/programs/pmma/about-pmma/

How to construct a multidimensional poverty indicator

- It must understandable and easy to describe
- It must conform to "the reality" of poverty
- It must be able to target the poor, track changes, and guide policy.
- It must be technically solid
- It must be operationally viable
- It must be easily replicable

How to construct a multidimensional poverty indicator

- Need an adaption of the data collection/ information system to collect the relevant indicators
- Need to apply specific methods for multidimensional phenomenon
  - regarding identification of the poor
  - regarding aggregation of the information

How to construct a multidimensional poverty indicator

1. How many dimensions/ What dimensions?
   - Arbitrary/ ad hoc choice (most common approach)
   - Testing of the significant dimensions (Fussco, 2006)
2. Which indicators/ How to measure it?
   - Quantitative versus qualitative indicators ?
   - Cardinal vs ordinal measure.
3. Poverty Line / Cut off (**Identification**)
4. Relations between the different items within one dimensions and between the different dimensions of poverty (**Aggregation**)
   - Aggregation in one unique measure/ score or truly multidimensional concept?
   - Homogenous items or hierarchical items within dimensions?

Data

- "Mutidimensional" Data

Example 1

Matrix of well-being score for n=4 persons, d=4 dimensions

$$\begin{pmatrix} \text{income} & \text{years of schooling} & \text{self-reported health} & \text{access to water} \\ 13.1 & 14 & 4 & 1 \\ 15.2 & 7 & 5 & 0 \\ 12.5 & 10 & 1 & 0 \\ 20 & 11 & 3 & 1 \end{pmatrix}$$

- This matrix summarizes the distribution of d attributes over n individuals.
- one cell is achivement of individual i in dimension j
- one row vector *xi* denotes achievement of individual i in all d dimension
- one column vector x_j denotes achievement of individual i in all d dimension

How to construct a multidimensional poverty indicator

Identification

- Who is multidimensionnnaly poor?
- Identification function:
  $\rho(x_{ij}, z) = 1$ if poor, $\rho(x_{ij}, z) = 0$ if non poor
  - counting approach
  - aggregate poverty line approach

How to construct a multidimensional poverty indicator

Identification: counting approach

- dual cut-off
  1. determine if individual are deprived in each dimension
  2. identify if someone is poor base on identification function:
     - Union criterion (if deprived in a least one dimension)
     - Intersection criterion (if deprived on all dimension)

How to construct a multidimensional poverty indicator

Identification: aggregate poverty line approach

- a person is poor if her agregate achievement falls below a defined poverty line
  1. $\rho(x_{ij}, z) = 1$ if $\psi(x_i) < \psi(z)$, $\rho(x_{ij}, z) = 0$ otherwise
     ex : consumption expenditure item

How to construct a multidimensional poverty indicator

Aggregation

- How poor is a society?
- We want to summarize information on the poor (identified by the identification step)
  $=>$ What are the desirable properties : axioms

How to construct a multidimensional poverty indicator

Axioms

1. Natural extensions of the multidimensional case
2. Specific axioms for the multidimensional case

How to construct a multidimensional poverty indicator

Axioms

1. Symetry (anonymity): permutation of the line of the matrix
2. Replication invariance (population principle)
3. Scale Invariance (homogeneity of degree 0)

How to construct a multidimensional poverty indicator

Axioms

1. Focus
   - focus on those that are multidimensionally poor (aggregate poverty line approach)
   - focus on the dimension where multidimensionnally poor are deprived (counting aproach)
2. Continuity
3. Monotonicity
   - become less deprived in one specific dimension
   - become less deprived in one less dimension

How to construct a multidimensional poverty indicator

Axioms

1. Sub-group decomposeability
2. Decomposeability across dimension
3. Transfer axioms

How to construct a multidimensional poverty indicator

Specific Axioms

$$x = \begin{matrix} \text{Income} & \text{Education} & \text{Health} \end{matrix} \begin{bmatrix} 7 & 7 & 2 \\ 3 & 3 & 8 \\ 10 & 10 & 12 \end{bmatrix} \begin{matrix} \text{Person 1} \\ \text{Person 2} \\ \text{Person 3} \end{matrix} \quad y = \begin{matrix} \text{Income} & \text{Education} & \text{Health} \end{matrix} \begin{bmatrix} 7 & 7 & 8 \\ 3 & 3 & 2 \\ 10 & 10 & 12 \end{bmatrix} \begin{matrix} \text{Person 1} \\ \text{Person 2} \\ \text{Person 3} \end{matrix}$$

$$z = \begin{bmatrix} 4 & 5 & 3 \end{bmatrix}$$

- Same distribution for each dimension but different correlation b/w dimensions

$=>$ requires an axiom on correlation of dimensions when marginal distribution are the same

How to construct a multidimensional poverty indicator

Specific Axioms

1. If you think that good health can substitute for bad income or bad education then poverty should decrease
2. If you think that good health is necessary to achieve good eduction, then poverty should increase
3. If you think that health is not necessary to achieve other dimensions, poverty should not change

How to construct a multidimensional poverty indicator

Measure deprivation

- Fuzzy approach
- Fuzzy and relative approach
- Axiomatic approaches

  see Deutsch, J., Silber, J., 2005. Measuring Multidimensional Poverty. An Empirical Comparison of Various Approaches. The Review of Income and Wealth. 51, 145-174

How to construct a multidimensional poverty indicator

Linear measures of material deprivation

$$S = \frac{1}{N} \sum_{n=1}^{N} s_i$$

where $s_i = \frac{1}{K} \sum_{j=1}^{K} w_j x_{ij}$ is a linear combination of K deprivation items for a respondent i.

How to construct a multidimensional poverty indicator

Linear measures of material deprivation

$$S = \frac{1}{N} \sum_{n=1}^{N} s_i$$

1. Equal weight
$$w_j^{\mathrm{eq}} = \frac{1}{K}$$
2. Cerioli-Zani
$$w_j^{\mathrm{cz}} \propto \log\left(\frac{1}{\bar{d}_j}\right).$$
3. Betti-Verma
$$w_j^{\mathrm{bv}} \propto \left(w_j^{\mathrm{cz}} \times w_j^{b}\right)$$

with

$$w_j^{b} = \left(1 + \sum_{m=1}^{M} \rho_{jm} \mathrm{I}(\rho_{jm} < \rho_H)\right)^{-1} \left(\sum_{m=1}^{M} \rho_{jm} \mathrm{I}(\rho_{jm} \geq \rho_H)\right)^{-1}$$

Examples

- Human Poverty Index, 1997 - *Marginal measure*
- Multidimensional Poverty Index, 2010- *Joint measure*- Alkire-Foster method.
- Fusscio, 2006 - *Rasch model*

Human Poverty Index

- Developped by the PNUD for the Human Development Reports in the 1990
- "A composite index measuring deprivations in the three basic dimensions captured in the human development index — a long and healthy life, knowledge and a decent standard of living

Human Poverty Index

- HPI_1: deficiencies in health (percentage of individuals whose life expectancy is less than 40 years),
- HPI_2: deficiencies in education (proportion of the adult population that is illiterate)
- HPI_3: deficiencies in terms of living conditions (proportion of the population having access to health care, safe water and proportion of children under age five suffering from malnutrition).
- The composite index HPI was formulated by Arnand and Sen (1997) as follows:

$$HPI = (\gamma_1 HPI_1 + \gamma_2 HPI_2 + \gamma_3 HPI_3)^{1/\alpha}$$

with $\gamma_1 + \gamma_2 + \gamma_3 = 1$ and $\alpha \geq 1$

Human Poverty index

Identification and agregation

- **Identification**: Who is poor?
  One cut-off (poverty line) for each dimension
- **Agregation**:
  - $\alpha = 1$: perfect substitutes.
  - $\alpha \to \infty : HPI \to max(HPI_1, HPI_2, HPI_3)$. In this case, the HPI will only decrease if its highest-valued component decreases.

Human Poverty index

Example

Welfare matrix

$$\begin{pmatrix} \text{Life expectancy} & \text{Illiterate} & \text{Access to health care} & \text{Access to water} \\ 45 & 0 & 0 & 0 \\ 39 & 1 & 0 & 1 \\ 54 & 1 & 1 & 1 \\ 32 & 1 & 0 & 0 \end{pmatrix}$$

1. Define the cut-offs

Life expectancy	Illiterate	Access to health care	Access to water
40	1	1	1

2. Generate the deprivation matrix

Life expectancy	Illiterate	Access to health care	Access to water
0	0	0	0
1	1	0	1
0	1	1	1
1	1	0	0

3. Agregation

Life expectancy	Illiterate	Access to health care	Access to water
0.5	0.75	0.25	0.5

Human Poverty index

- Marginal measure
  - Apply a deprivation cutoff for each vector
  - But takes an aggregate over the population (sum over the columns of the matrix)
    $=>$ Inadequate identification

$$\begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 \end{pmatrix}$$

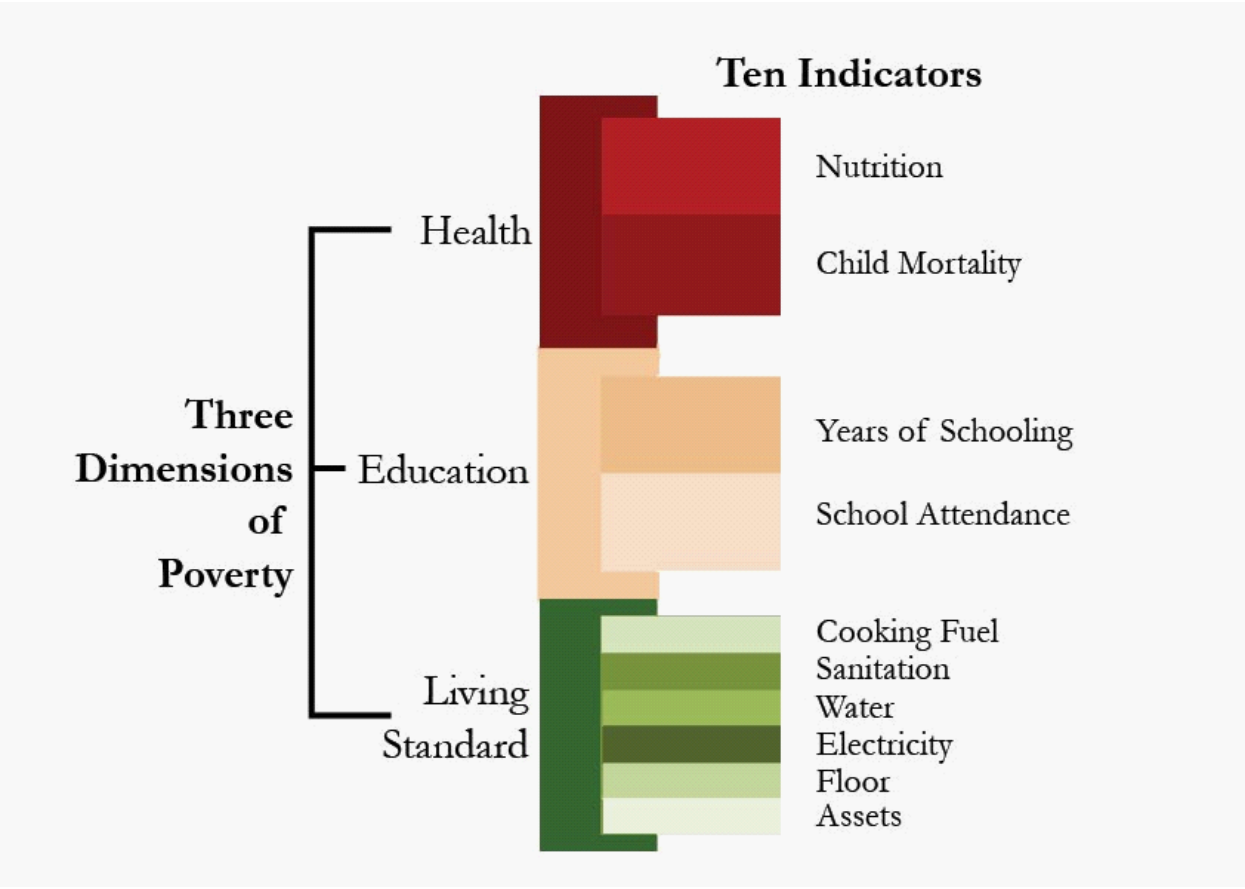
$$0.25 \quad 0.25 \quad 0.25 \quad 0.25$$

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$0.25 \quad 0.25 \quad 0.25 \quad 0.25$$

Multidimensional Poverty Index

- Featured in the United Nations Development Programme 2011 Human Development Report



Multidimensional Poverty Index

Indicators

Indicators	Deprivationcut-o
Education (each indicator is weighted equally at1/6)	
Years of Schooling:	deprived if no ho
School Attendance:	deprived if any s
Health(each indicator is weighted equally at 1/6)	
ChildMortality:	deprived if any c
Nutrition	deprived if any a
Living standards (each indicator is weighted equally at 1/18)	
Electricity:	deprived if the h
DrinkingWater	deprived if the h
Sanitation	deprived if they
Flooring	deprived if the h
CookingFuel	deprived if the h
Assets	deprived if the h

Multidimensional Poverty Index

Identification and Agregation

- **Identification**: Who is poor?

A person is identified as multidimensionally poor if he or she is deprived in **one third or more of the dimensions.**
= **Dual cut-off approach**: One cutoff within each dimension to determine whether a person is deprived
A second cutoff across dimensions that identify the poor by counting the number of deprivation (sum over the rows first)

- **Aggregation**: **FGT measures**

=> the indicator is able to calculate incidence, intensity and depth of poverty

Multidimensional Poverty Index

Example

Welfare matrix

income	years of shooling	self-reported health	access to water
13.1	14	4	1
15.2	7	5	0
12.5	10	1	0
20	11	3	1

Cut-off

income	years of schooling	self reported health	access to water
13	12	3	1

Multidimensional Poverty Index

Example

Deprivation matrix

$$\begin{pmatrix} \text{Income} & \text{Years of schooling} & \text{Self-reported health} & \text{Access to water} \\ 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 \end{pmatrix}$$

$$\begin{pmatrix} \\ 0 \\ 2 \\ 4 \\ 1 \end{pmatrix}$$

Multidimensional Poverty Index

Example

Union or intersection?

Empirically (Alkire and Seth, 2009)

k	Headcount
1	91.2
2	75.5
3	54.4
4	33.3
5	16.5
6	6.3
7	1.5
8	0.2
9	0
10	0

Multidimensional Poverty Index

Example

- If the poverty line is set to 2 deprivation (K=2), the poverty headcount is H= $\frac{1}{2}$
  If the number of deprivation rises for one person, the headcount do not change => violates dimensional monotonicity
- Need to add information: deprivation share for the individual that are poor
  - A= $\frac{3}{4}$, average deprivation share among the poor
  - Adjusted Headcount ratio: M_0= 6/16=0,375
- NB: censored matrix

Deprivation matrix

$$\begin{pmatrix} \text{Income} & \text{Years of schooling} & \text{Self-reported health} & \text{Access to water} \\ 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 \end{pmatrix}$$

$$\begin{pmatrix} \text{counting approach} \\ +\text{dual cut-off} \\ \\ \overline{} \\ 2/4 \\ 4/4 \\ \\ \underline{} \end{pmatrix}$$

Multidimensional Poverty Index

Example

Normalized poverty gap

Income	Years of schooling	Self-reported health	Access to water
0	0	0	0
0	0.42	0	1
0.04	0.17	0.67	1
0	0.008	0	0

Normalize squared poverty gap

Income	Years of schooling	Self-reported health	Access to water
0	0	0	0
0	0.176	0	1
0.002	0.029	0.449	1
0	0.006	0	0

Multidimensional Poverty Index

- Index valid for ordinal data (identification & aggregation)
- Robust to monotonic transformations of data.
- Similar to traditional measure of poverty (FGT)
- Easy to calculate, easy to interpret
- Can be broken down by dimension and policy
- Dominance Results
- Characterization via freedom – P&X 1990

A more systematic approach: Rasch model

- What if we do not preclude what are the important dimensions of poverty and how do they aggregate in a single indicator ?
- Rasch model (Fussco, 2006):
  - Identify the different independent domains to be included in the composite index as well as their weights. The obtained index leads to a robust ranking of poverty level
  - Identify the relations between the items (how they aggregate)
  - Identify the 'true multidimensionality" or the unidimensionality nature of poverty

Other approaches

We have seen in detail some approaches

- Other aggregate indicators exist
  - The supplementary strategy (Brandolini and D'Alessio, 1998)
  - The global composite index (Bourguignon and Chakravarty, 2003; Chiappero, 1994)
- We can also find approaches based on the position on each attribute
  - The cut-off method (Townsend, 1979; 1987)
  - The fuzzy sets approach (Zadeh, 1965)
  - The totally fuzzy approach (Cerioli and Zani, 1990)
  - The totally fuzzy and relative approach (Cheli and Lemmi, 1995)

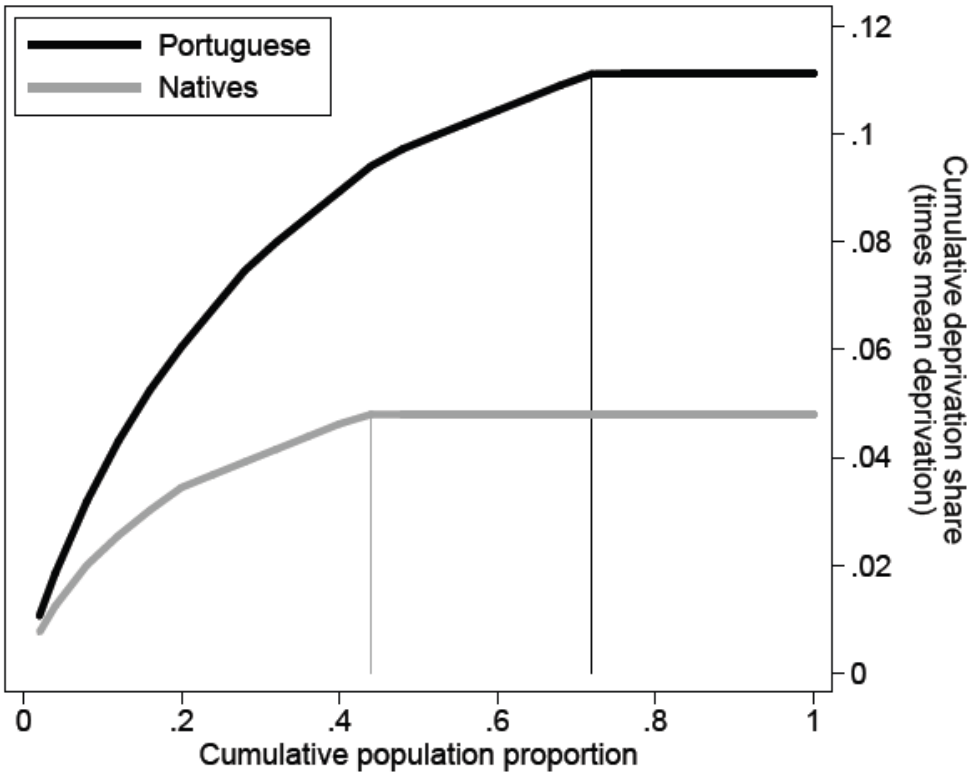
Other approaches

- Approaches based on individual data
  - The distance function approach (Deutsch and Silber, 2005)
  - The information theory approach (Lugo and Maasoumi, 2008)
  - The inertia approach (Asselin, 2009)
    - Principal Component Analysis (Filmer and Prichett, 2001)
    - Factor Analysis (Sahn and Stifel, 2003)
    - Multiple Correspondence Analysis (Booysen, 2007)
    - Cluster Analysis (Ferro Luzzo et al., 2006)

Graphical representation

- Inverse generalized Lorenz curve, distribution of deprivation
  $IGL = \frac{1}{N} \sum_i s_i$
  where the sample values are ordered by deprivation score si
  where $s_i = \frac{1}{K} \sum_{j=1}^{K} w_j x_{ij}$ is a linear combination of K
  deprivation items for a respondent i.

Graphical representation



Max,CZ (fully staturated model reweighting)