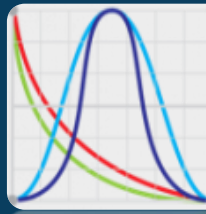




**Bristol Poverty Institute**  
University of Bristol



**ACEIR**  
AFRICAN CENTRE OF EXCELLENCE  
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**Programa  
Universitario  
de Estudios  
del Desarrollo**  
UNAM

# Advanced Poverty Research Methods

## A critical review of axiomatic approaches and multidimensional indices

Dr. Curtis Huffman Espinosa

Online Course, 22nd November to 9th December 2021



# Overview

There seems to be some degree of confusion nowadays regarding what is meant by measurement in poverty research (dimensionality, observability, model, replicability). In this talk we draw on the Epistemology of Measurement to bridge this conceptual gap.

## Key References

- Nájera Catalán, H. E., & Gordon, D. (2020). The Importance of Reliability and Construct Validity in Multidimensional Poverty Measurement: An Illustration Using the Multidimensional Poverty Index for Latin America (MPI-LA). *The Journal of Development Studies*, 56(9), 1763-1783, DOI: 10.1080/00220388.2019.1663176.
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- Tal, E. (2017). A Model-Based Epistemology of Measurement. In Mößner, N., & Nordmann, A. (Eds.), *Reasoning in Measurement* (1<sup>st</sup> ed., pp. 245-265). Routledge, DOI:10.4324/9781781448717

## What we talk about when we talk about measurement

Tal, E. (2015). Measurement in Science. In E.N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Fall 2020 ed.) <https://plato.stanford.edu/archives/spr2017/entries/measurescience> (Accessed 11 November 2021)

“Most (but not all) contemporary authors agree that measurement is an activity that involves **interaction** with a concrete system with the aim of **representing** aspects of that system in abstract terms (e.g., in terms of classes, numbers, vectors etc.)” [Our emphasis]





# “Measurement Theory”

Suppes, P. (1998). Theory of Measurement. In *Routledge Encyclopedia of Philosophy*, Taylor and Francis, <https://www.rep.routledge.com/articles/thematic/measurement-theory-of/v-1> (Accessed 11 November 2021).  
DOI:10.4324/9780415249126-Q066-1

- “A conceptual analysis of measurement can properly begin by formulating the two fundamental problems of any measurement procedure.”
  - “The first problem is that of **representation**, justifying the assignment of numbers to objects or phenomena.”[Added emphasis]
  - “[T]he second fundamental problem...[is] determining the scale type of a given procedure.”



# “Measurement Theory”

- A measurement outcome **has to represent** the target in a certain fashion (*mirror relevant relations* among the objects being measured), but how can one tell?
  - “We cannot literally take a number in our hands and ‘apply’ it to a physical object. What we can show is that the structure of a set of phenomena under certain empirical operations and relations is the same as the structure of some set of numbers under corresponding arithmetical operations and relations.” Suppes, P. (1998)
- How can we “show” (provide empirical evidence) that certain features of the world bear resemblance with some set of numbers (encodings nowadays usually located on computers) in terms of certain operations and relations?
- Mathematical theories of measurement do not elaborate on the assumptions, inference patterns, evidential grounds or success criteria associated with such methods.
- Until very recently the philosophy of measurement offered little by way of an answer.





# Epistemology of Measurement

How can one tell whether an instrument measures the quantity it is intended to?

How do *calibration* procedures establish *accuracy*?

- Since the early 2000s, questions regarding how measurement produces knowledge returned to the forefront of philosophical discussion after several decades of relative neglect.
- This recent body of scholarship is sometimes called “the epistemology of measurement”, and includes a rich array of works that emphasizes the relationships between measurement and theoretical and statistical modeling.



# Epistemology of Measurement

Model-based accounts have been developed by studying measurement practices in the sciences, and particularly in metrology (a field of study concerned with the design, maintenance and improvement of measuring instruments in the natural sciences and engineering)

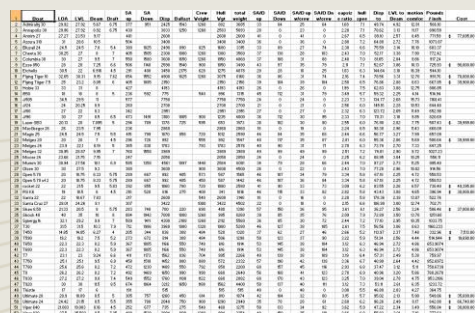
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- Mari, L. (2005). “Models of the Measurement Process”, in *Handbook of Measuring Systems Design*, vol. 2, P. Sydenman and R. Thorn (eds.), Wiley, Ch. 104.
- Mari, L. and A. Giordani (2013). “Modeling measurement: error and uncertainty”, in *Error and Uncertainty in Scientific Practice*, M. Boumans, G. Hon, and A. Petersen (eds.), Ch. 4.
- Tal, E. (2017a). “A Model-Based Epistemology of Measurement”, in Mößner & Nordmann (eds.) 2017, 233–253.
- Tal, E. (2017b). “Calibration: Modelling the Measurement Process”, *Studies in History and Philosophy of Science (Part A)*, 65: 33–45.

# Indications vs. Outcomes

According to model-based accounts (and the Joint Committee for Guides in Metrology) measurement consists of two levels

- A concrete process involving interactions between an object of interest (the “system under measurement”), an instrument, and the environment, which includes the measuring subjects
  - **Instrument indications** (or “readings”)
    - Properties of the measuring instrument in its final state after the measurement process is complete (digits on a display, marks on a multiple-choice questionnaire, bits stored in a device’s memory)
- A theoretical and/or statistical model of that process (an abstract and local representation constructed from simplifying assumptions)
  - **Measurement outcomes** (or “results”)
    - Knowledge claims about the values of one or more quantities attributed to the object being measured
    - formulated in terms of an abstract and universal concept—e.g. mass, current, temperature, duration or poverty

**Inferences are not trivial!**



Principales Resultados  
**ENIGH 2020**  
Encuesta Nacional de Ingresos y Gastos de los Hogares



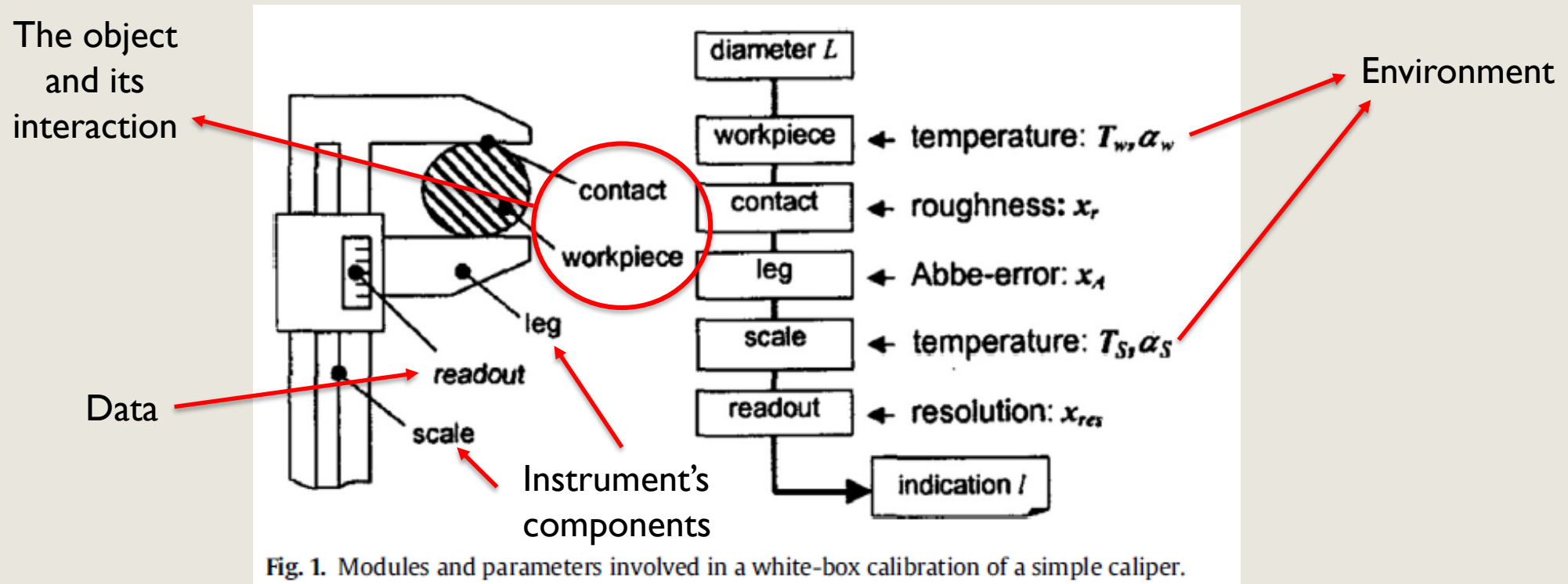


# Inferring measurement outcomes

- Measurement proceeds by representing instrument interactions with a set of model parameters, and assigning values to a subset of those parameters (known as “measurands”) based on the results of the interactions.
- Inferences from instrument indications to measurement outcomes are **nontrivial and depend on a host of theoretical and statistical assumptions** about the object being measured, the instrument, the environment and the calibration process (the workings of the instrument and its interactions with the object and environment, including human operators).
- Measurement is viewed as a set of procedures whose aim is to assign values to model parameters based on instrument indications, in a manner that satisfies certain epistemic desiderata (pass as credible evidence).

# Inferring measurement outcomes

A modular (white-box) representation of a simple caliper measurement



Source: Schwenke, H., Siebert, B. R. L., Wäldele, F., & Kunzmann, H. (2000). Assessment of uncertainties in dimensional metrology by Monte Carlo simulation: proposal of a modular and visual software. *CIRP Annals*, 49(1), 395-398.



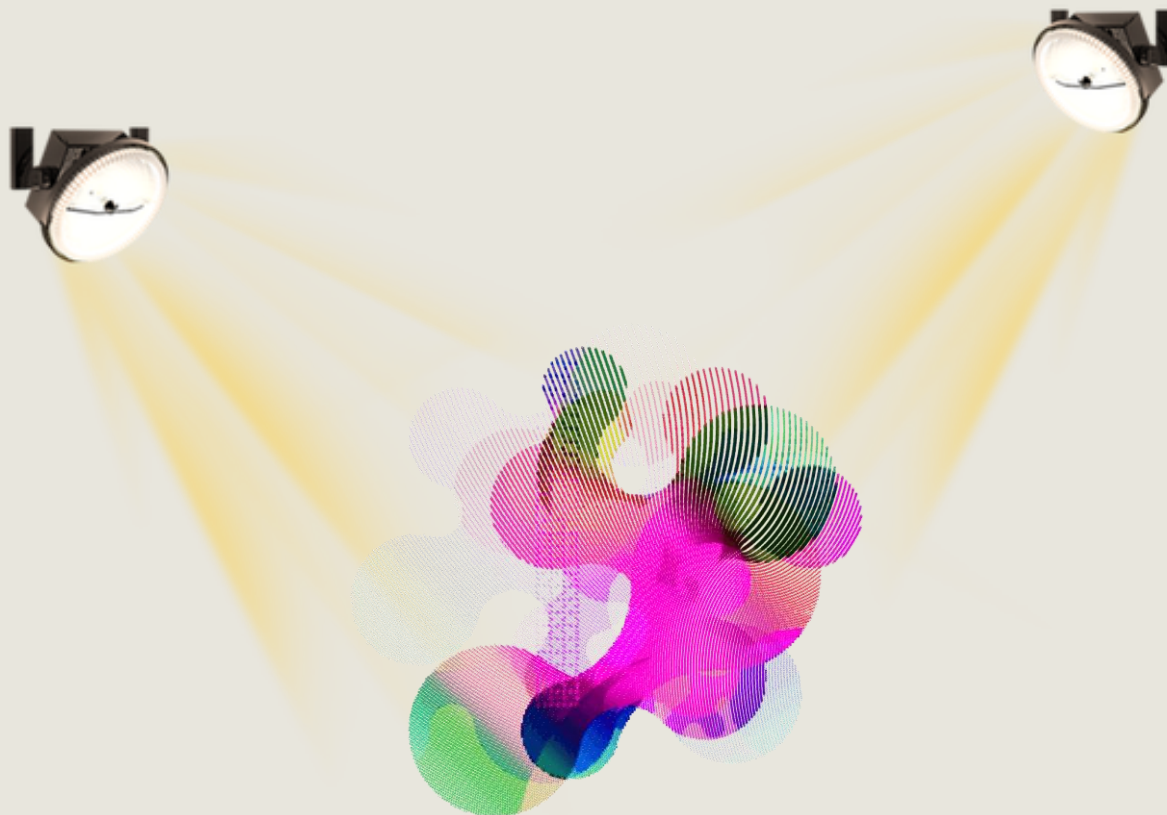
# No model, no measurement

- The same indications produced by the same measurement process may be used to establish different measurement outcomes depending on how the measurement process is modeled
  - which environmental influences are taken into account,
  - which statistical assumptions are used to analyze noise
  - which approximations are used in applying background theory
- Models are **necessary preconditions** for the possibility of inferring measurement outcomes from instrument indications, and crucial for determining the content of measurement outcomes.
- Any measurement result reports information that is meaningful **only in the context** of a metrological model
- Models provide the **necessary context** for evaluating various aspects of the goodness of measurement outcomes, including accuracy, precision, error and uncertainty



# No model, no measurement

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# No model, no measurement

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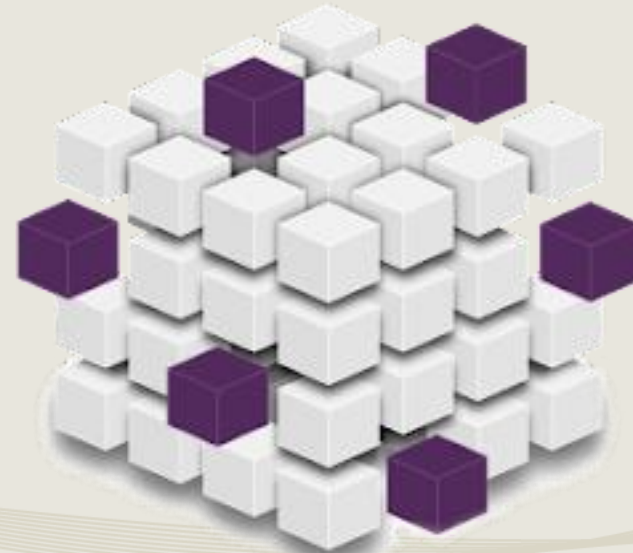
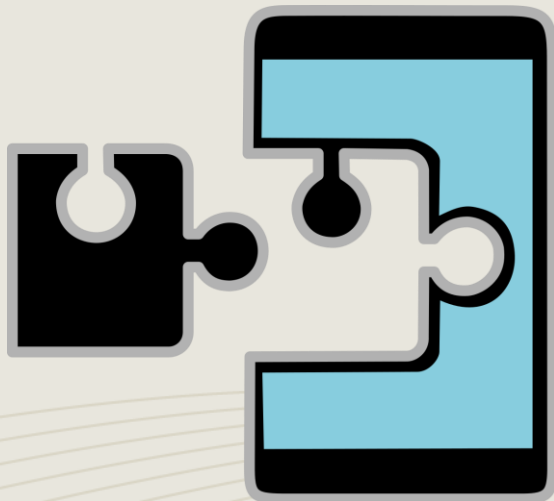
# Measurement outcomes must represent

## What counts as credible evidence? (key normative requirement)

- Coherence of model assumptions with relevant background theories or other substantive presuppositions about the quantity being measured (to ensure that the intended quantity is being measured)
- Mutual consistency of measurement outcomes across different measuring instruments, environments and models (to ensure that measurement outcomes can be reasonably attributed to the measured object rather than to some artifact of the measuring instrument, environment or model)
- Taken together, these two requirements ensure that measurement outcomes remain valid independently of the specific assumptions involved in their production, and hence that the context-dependence of measurement outcomes does not threaten their general applicability

# Undertheorized measurement model?

- The problem with under theorizing the interactions between that which we purport to measure (poverty), our instrument (the survey), and the environment (which includes the measuring subjects) is the lack of framework against which one is to understand the weight of the different pieces of evidence in favor of interpreting a particular set of scores as representing the target (proper measurement).





# MPI for the Latin America

## the review of **income and wealth**

Review of Income and Wealth  
Series 64, Number 1, March 2018  
DOI: 10.1111/roiw.12275

### A MULTIDIMENSIONAL POVERTY INDEX FOR LATIN AMERICA

BY MARIA EMMA SANTOS\* and PABLO VILLATORO

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Comision Economica para America Latina y el Caribe (CEPAL), Santiago, Chile*



# MPI for the Latin America

- 13 indicators grouped in 5 dimensions across 17 different (harmonized) data sets

TABLE 1  
SURVEY DATA USED

Country	Survey	Initial Year	Final Year	Sample Size (people)	
				Initial Year	Final Year
Argentina	Encuesta Permanente de Hogares	2005	2012	188,755	223,617
Bolivia	Encuesta Continua de Hogares	2003	2011	38,500	33,821
Brazil	Pesquisa Nac. Por Amostra de Domicilios	2005	2012	408,148	362,451
Chile	Encuesta de Caracterización Socioeconómica Nacional	2003	2011	271,716	200,302
Colombia	Gran Encuesta Integrada de Hogares	2008	2012	823,814	812,711
Costa Rica	Encuesta de Hogares de Propósitos Múltiples/Encuesta Nacional de Hogares	2005	2012	43,682	39,390
Ecuador	Encuesta de Empleo, Desempleo y Subempleo	2005	2012	77,050	73,686
El Salvador	Encuesta de Hogares de Propósitos Múltiples	2004	2012	70,558	85,636
Guatemala	Encuesta Nacional de Condiciones de Vida	2000	2006	37,771	68,739
Honduras	Encuesta Permanente de Hogares de Propósitos Múltiples	2006	2010	97,610	32,539
Mexico	Encuesta Nacional de Ingresos y Gastos de los Hogares	2004	2012	33,726	91,738
Nicaragua	Encuesta Nac. de Hogares sobre Medicion de Niveles de Vida	2005	2009	36,612	30,432
Paraguay	Encuesta Permanente de Hogares	2005	2011	19,579	19,740
Peru	Encuesta Nacional de Hogares, Condiciones de Vida y Pobreza	2003	2012	56,265	98,828
Rep. Dom.	Encuesta Nacional de Fuerza de Trabajo	2006	2012	30,038	29,130
Uruguay	Encuesta Continua de Hogares	2005	2012	54,330	120,462
Venezuela	Encuesta de Hogares por Muestreo	2005	2012	165,079	154,276



# MPI for the Latin America

The Alkire-Foster Adjusted Headcount Ratio  $M_0$  (Alkire, S., Roche, J. M., Ballon, P., Foster, J., Santos, M. E., & Seth, S. (2015). *Multidimensional poverty measurement and analysis*. Oxford University Press, USA.)

$$M_0 = \frac{1}{n} \sum_{i=1}^n \sum_{j=1}^d w_j g_{ij}^0(k)$$

- $k$  is the proportion of weighted deprivations a person needs to experience in order to be considered multidimensionally poor (poverty cut-off)
- $g_{ij}^0$  signals deprivation of person  $i$  in indicator  $j$  according to the level of achievement considered sufficient in order to be non-deprived in each indicator (the corresponding indicator's cut-off).
- $w_j$  indicators weight such that  $\sum_j w_j = 1$





# MPI for the Latin America

## Regarding the relative weight or value of each indicator

- The housing, basic services, living standard and education dimensions are equally weighted with 22.22%,
- The social protection dimension receives half of this weight, 11.11%.
- Weights within dimensions are
  - equally distributed in the case of the housing, basic services and education dimensions, and
  - unequal within the living standard and the social protection dimensions,
    - income and employment receiving twice the weight of durable goods and social protection within the corresponding dimensions.
- All deprivations receive the same weight (7.4%) except for social protection (3.4%) and income (14.8%).



# Does $M_0$ measure (represent) poverty?

Often, in the axiomatic approach literature, mathematical properties are offered as prove of the “good” behavior of statistics in different situations (confusing quantified indications,  $M_0$ , with measurement outcomes)

The Alkire-Foster Adjusted Headcount Ratio  $M_0$  (Alkire, S., Roche, J. M., Ballon, P., Foster, J., Santos, M. E., & Seth, S. (2015). *Multidimensional poverty measurement and analysis*. Oxford University Press, USA.)

- The  $M_0$  index of multidimensional poverty, given their mathematical structure, satisfy several principles or axioms (properties) [arguably] desirable for policy [in principle, on paper].
  - Allows for decompositions in population groups (**subgroup decomposability**)
  - It can be broken down by indicator (**dimensional breakdown**)
  - Whenever the corresponding indicators, and cut-offs , signal a poor person/household ceases to be deprived in a dimension,  $M_0$  decreases (**dimensional monotonicity**)
  - it can be implemented with ordinal data (**ordinality**)



# Does $M_0$ measure (represent) poverty?

- Indeed, in most cases one seeks to establish monotonic functions that uniquely map instrument indications to values of the quantity being measured (poverty), i.e. measurement outcomes. Up to the limits of uncertainty.
- But, to attain the status of measurement outcome, a *reliable* relation between  $M_0$  and poverty (the system under measurement) needs to be shown. This is an **empirical question** not answered by its mathematical structure (which is neither necessary nor sufficient).
  - If **measurement standards** were at hand, we would only need look at the correlations among  $M_0$  and the set of reference systems that are associated with the known fixed values (no matter the functional form of  $M_0$ ).
  - With no measurement standards, one needs to look for empirical evidence of said reliable relation elsewhere (by way of *calibration functions*).



# Does $M_0$ measure (represent) poverty?

Dimensions (5), indicators (13), weights and cut-offs are justified on

- Normative judgements (closely related to)
  - Millennium Development Goals
  - Sustainable Development Goals
  - Common sense
    - The rich experience in the LA region
    - Widely recognized as constituent elements of poverty
    - The literature on global poverty
    - Intrinsic value for a life with human dignity
  - The configuration of sectorial policies (areas of social policy)
  - Thematic specialization of international agencies and programmes
    - UN-Habitat
    - Joint Monitoring Programme for Water Supply, Sanitation and Hygiene
    - Global Tracking Framework
    - UNESCO
    - International Labour Organization
- Empirical exploration of the data
  - Factor analysis
  - Correlation
  - Redundancy analysis
  - Robustness analysis



# Does $M_0$ measure (represent) poverty?

**Without an abstract representation** of the interactions between poverty, survey items, and the survey protocol (the measurement model) **there is no way to tell** if the MPI-LA represents (bears resemblance with/mirrors) poverty.

A theoretical framework is needed as several questions need answers **before one can assess the credibility** of the evidence being put forward.

- How does poverty relate to Millennium and Sustainable Development Goals?
- Does that make the poverty cut-off  $k$ (25%) reasonable? (deprivation in any full dimension is not enough)
- Should we include more dimensions?
  - “There are dimensions that we would have liked to include and could not due to data limitations, such as health... Indicators on fundamental cognitive skills, employment formality and quality are other important missing indicators.”
- Would this inclusion of more dimensions change our conception/definition of poverty?
  - “What dimensions comprise poverty itself?” (Alkire, 2013)
- Do we need a census of dimensions if one is to “capture” poverty in the region (at a given time and place)?





# Does $M_0$ measure (represent) poverty?

- How does the Millennium and Sustainable Development Goals relate to the data collection instruments?
  - “Even the data collection on income information, housing, basic services and ownership of durable goods requires further harmonization and improvements.”
- How are researchers to assess whether the variables in the data set (instrument indications), from which the MPI-LA is computed, reflect non-negligible influences from other things different from poverty? (the interaction with the environment)
  - Think about the possibility that one of the indicators included in the MPI-LA, say the one encoding the answers to a question related to unemployment relates, in a non-negligible part, to the fact that an individual can afford not having a job because he or she is actually not-poor.
    - In this case the index would go up whereas poverty would go down
    - How are researchers to assess the magnitude of this misalignment and decide whether this ends up being negligible or not?
    - How should we evaluate whether this is the case in every relevant context (for all 17 countries)?



# Does $M_0$ measure (represent) poverty?

- Why should the (13) chosen indicators correlate in the first place?
  - Santos, M. E., & Villatoro, P. (2020). The Importance of Reliability in the Multidimensional Poverty Index for Latin America (MPI-LA). *The Journal of Development Studies*, 56(9), 1784-1789, DOI: 10.1080/00220388.2019.1663177.
    - “Assess de MPI-LA indicators based on the on their correlations is at odds with the motivation for constructing a multidimensional poverty index.”
    - “...one of the motivations for moving from income or consumption poverty to multidimensional poverty is precisely the low association between the different kinds of deprivations (Alkire et al., 2015, chapter 1).”

These are questions that researchers simply cannot ignore (or assume away) if they are to make a reasonable case for the MPI-LA **to be considered a measurement outcome**. And a case needs to be made indeed.



# Does $M_0$ measure (represent) poverty?

- David Gordon and Shailen Nandy, “Measuring child poverty and deprivation”, In: *Global Child Poverty and Well-Being*, Alberto Minujin and Shailen Nandy (eds), 2012.
  - “[The MPI does] not have an explicit definition or theory of poverty. The absence of a definition means that it is impossible to determine the validity of their worked example”
  - “The problem with the Multidimensional Poverty Index method is that there remains uncertainty about the following:
    - How many dimensions there are – three? (education, health and standard of living) Or six? (food, education, health, dwelling conditions, water and sanitation and standard of living)
    - How these dimensions are related – that is, are the education and health dimensions orthogonal – at  $90^\circ$  to each other with correlation = 0? Or are these two dimensions correlated, that is, at  $45^\circ$  with correlation = 0.5?
    - The indicators are imperfect and it is not known how they correlate with each dimension”



# The Alkire-Foster aggregation method

The Alkire-Foster (AF) aggregation method, applied by Maria Emma Santos and Pablo Villatoro in their MPI-LA, was never meant to address such questions (as measurement model).

- Alkire, S. (2013) “Choosing dimensions: The capability approach and multidimensional poverty”. In: *The many dimensions of poverty*, Springer.

The AF aggregation method

- “... offered a framework with respect to which various research and policy questions about multidimensional poverty can be analyzed, and the multiple deprivations which so many suffer can be reduced.”

Rather than embarking in what Sabina Alkire has labeled as the

- “empirical overambitiousness”

of a

“quixotic search for the perfect measure”,

The AF method aimed to offer a valuable tool

- “*sufficient* to guide multidimensional poverty reduction efforts to critical objectives.” [emphasis in original]

As a goal-monitoring tool, it delivered as promised. **But did not get us any closer to a poverty measure.**



# What is poverty measurement good for?

Should we care for anything else other than to keep tabs on (monitoring) intended-outcomes of social development interventions in their own terms?

If an intended-outcome monitoring (dashboard) approach can indeed inform development public-policy, do we actually need a poverty measure?

- Renouncing to poverty measurement seriously compromises scientific generalization. It reduces all quantitative comparisons, both geographical and in time, to whatever researchers can collectively assume the data sets at hand represent.
- When the problem that represents measuring something is overlooked/trivialized, the distinction between poverty and the means used to explore it gets diluted as the data variables (instrument indications) used in the computation of the scores, for all intents and purposes, become indistinguishable from poverty itself.
- This leads to an undesirable multiplicity of the concept in detriment of comparability as the definition of poverty becomes dependent not only on the chosen dimensions (the particular data variables) that go into the algorithm, but the particular data set used (a sample collected at a particular time and place).





# Quixotic overambitiousness?

If only we had a 100+ year old quantitative framework that allowed us to produce/assess the key normative requirements of good old fashion measurement





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*¡Bienvenidos  
estudiantes!*

