Designing the Inequality-Adjusted Human Development Index (IHDI)

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Human Development Index

Motivation

- Go beyond per capita income as a wellbeing measure
  - Ends as well as means
- Broaden space
  - First form of heterogeneity (F. Bourguignon)
- Practical indicator
  - Substantial coverage with existing data
  - Easy to understand

Human Development Index

Issues

(i) Choice of dimensions (variables)

income (GDP per capita to become GNI per capita)

education (literacy/enrolment to become years education/school life expectancy)

health (life expectancy)

Why only these?

(ii) Measurability of variables (cardinal or ordinal)

assumes cardinal (at least interval scale)

How can you justify?

(iii) Comparability of variables(full, partial or not at all)

full after normalizing to a common range [0,1]

How does empirical become normatively relevant?

(iv) Aggregation and weighting (general functions?)

mean of means

What about second form of heterogeneity? Inequality

This Paper

Theory

- Address issue (iv) inequality using FLS (2005)
  - Assume issues (i-iii) solved
  - Provide plausible calibration method
- Construct IHDI
  - Based on Atkinson's ede instead of arithmetic mean
  - Focus on H_1 using geometric mean
  - And H_1* suppressing dimensional inequality
- Interpretation
  - IHDI and potential IHDI
  - Inequality adjustment used below in estimation
- Properties
  - H_1 satisfies usual properties
  - Invariance properties via geometric mean used below in ensuring robustness to calibration choices

This Paper

- Implementation
  - Revisit measurement assumptions (ii-iii)
    - Calibrating variables
  - Estimating indices
    - Potential IHDI H_1^*
      - Uses aggregate data arithmetic means
      - Combine using geometric mean
    - IHDI H_1
      - Geometric means unavailable for aggregate data
      - Use estimates of Atkinson's inequality measure to adjust mean
      - Combine using geometric mean
  - Example

Review of FLS

Notation

- x distribution of income
- y distribution of education
- z distribution of health
- D matrix of achievements

HDI

$H(D) = \mu[\mu(x),\mu(y),\mu(z)]$

Measure of average achievement

Equally distributed equivalent

- Assuming welfare has form
- $W(D) = \Sigma_i \Sigma j\ u(d_{ij})$ with u linear

HDI

$$H(D) = \mu[\mu(x),\mu(y),\mu(z)]$$

Properties

- symmetry in dimensions
- symmetry in people
- replication invariance
- normalization
- linear homogeneity
- monotonicity
- subgroup consistency

Problem

- Like per capita GNI, ignores inequality

Gini-adjusted HDI

Anand & Sen (1993) and Hicks (1997)

Use Sen welfare index to include inequality within dimensions

$S(x) = \mu(x)[1-G(x)]$	income
$S(y) = \mu(y)[1-G(y)]$	education
$S(z) = \mu(z)[1-G(z)]$	health

Note Mean achievement is discounted by inequality

Gini-adjusted HDI

$$H_G(D) = \mu[S(x),S(y),S(z)]$$

Properties

- Symmetry in dimensions, symmetry in people, replication invariance, normalization, linear homogeneity, monotonicity

Violates subgroup consistency

- $H_G(D)$ rises $H_G(D')$ rises $H_G(D;D')$ falls

Gain inequality sensitivity - but at some cost

- Not applicable to regional analysis
- Also not "path independent"
  - Results depend on order of aggregation
  - - people then dimensions vs. dimensions then people

Note Culprit is Gini in Sen welfare measure

Alternatives? Foster, Lopez Calva, Szekely (2005)

Inequality-adjusted HDI (IHDI)

Recall

Equally distributed equivalent income (ede)

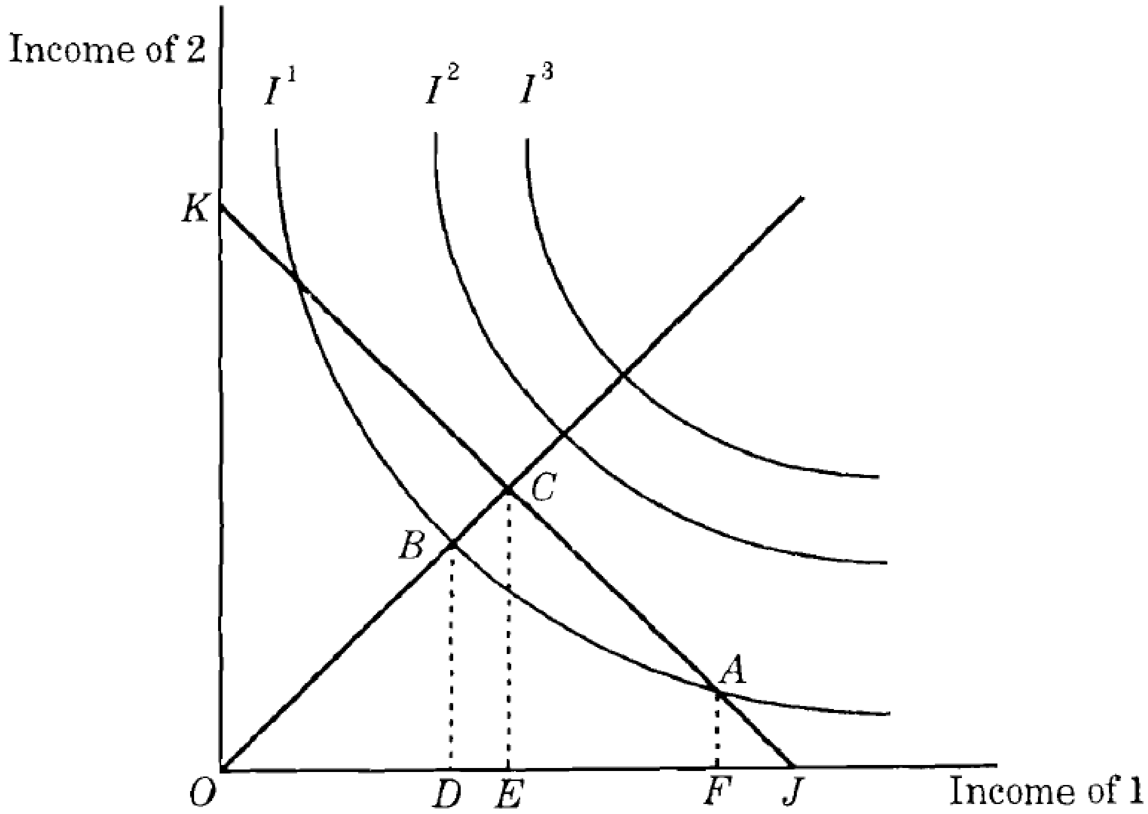
The income level which, if assigned to all individuals, produces the same social welfare as the observed distribution.

Note

For any W(x), the associated ede e(x) always ranks distribution the same way as W(x)

The ede e(x) is a welfare function

Equally Distributed Equivalent (ede)



A = initial income distribution

Three social welfare levels, I^1, I^2, I^3

Find the following:

Total income

Mean Income

Set of all possible distributions

Equally distributed equivalent income

Atkinson's ede

$$e_\alpha(x) = \begin{cases} \left[\frac{1}{n}\sum_{i=1}^{n} x_i^\alpha\right]^{1/\alpha} & \alpha \le 1, \alpha \ne 0 \\ \prod_{i=1}^{n} x_i^{1/n} & \alpha = 0 \end{cases}$$

$e_\alpha(x) = \mu_\alpha(x)$ general mean

$A_\varepsilon(x) = [\mu(x) - \mu_\alpha(x)]/\mu(x)$ inequality

$\mu_\alpha(x) = \mu(x)[1 - A_\varepsilon(x)]$ discounted for ineq

Inequality-adjusted HDI (IHDI)

$H_\varepsilon(D) = \mu_\alpha(D)$ for $\varepsilon > 0$, $\alpha = 1-\varepsilon$

- general mean applied to matrix
- ede achievement level

$\varepsilon = 0$ $H_0 = \mu[D]$ usual HDI

$\varepsilon = 1$ $H_1 = \mu_0 [D]$

based on geometric mean $g = \mu_0$

sensitive to inequality

$\varepsilon = 2$ $H_2 = \mu_{-1} [D]$

based on harmonic mean μ_{-1}

even more sensitive

Inequality-adjusted HDI (IHDI)

$$H_{\varepsilon}(D) = H_0(D)[1 - A_{\varepsilon}(D)]$$

Note

- Inequality adjusted
- Which inequalities?
  - Both within dimensions
  - And across dimensions

Interpretation

- H_0 is highest possible level of H_{ε} when one can freely transfer achievements across achievements and dimension
- H_{ε} indicates the actual IHDI

IHDI

Properties

- Symmetry in dimensions, symmetry in people, replication invariance, normalization, linear homogeneity, monotonicity
- Subgroup consistency

IHDI

Alternative definitions

$H_\varepsilon(D) = \mu_\alpha[\mu_\alpha(x), \mu_\alpha(y), \mu_\alpha(z)]$ aggregate within dimensions then across dimensions

$H_\varepsilon(D) = \mu_\alpha[\mu_\alpha(d_1),\ldots,\mu_\alpha(d_m)]$ aggregate at individual level then across persons

Path independence

- Conceptual
- Empirical – need only $A_\varepsilon(x)$, $A_\varepsilon(y)$, $A_\varepsilon(z)$ estimates

Note: Dimensions are not perfect substitutes

- Measure of complementarity: ε
- Sensitive to uneven growth
- Not sensitive to correlations!
  - See work by Seth (2010)

Family of Human Development Indices for Mexican States

Ranking	State	**H index e=0**	State	**H index e=3**	Ranking
1	Chiapas	0.5735	Oaxaca	0.3654	1
2	Oaxaca	0.5881	Chiapas	0.3797	2
3	Guerrero	0.5968	Guerrero	0.3995	3
4	Veracruz	0.6168	Veracruz	0.4337	4
5	Puebla	0.6232	Zacatecas	0.4401	5
6	Yucat‡n	0.6239	Yucat‡n	0.4497	6
7	Michoac‡n	0.6363	Michoac‡n	0.4509	7
8	San Luis Potos’	0.6370	Puebla	0.4545	8
9	Hidalgo	0.6449	San Luis Potos’	0.4641	9
10	Zacatecas	0.6482	Durango	0.4708	10
11	Guanajuato	0.6546	Tlaxcala	0.4747	11
12	Tlaxcala	0.6600	Hidalgo	0.4784	12
13	Durango	0.6608	Nayarit	0.4898	13
14	Querˇtaro	0.6637	Guanajuato	0.4937	14
15	Nayarit	0.6638	Chihuahua	0.5069	15
16	Tabasco	0.6646	Tabasco	0.5094	16
17	Morelos	0.6691	Morelos	0.5139	17
18	Campeche	0.6734	Querˇtaro	0.5146	18
19	Chihuahua	0.6739	Mˇxico	0.5185	19
20	Tamaulipas	0.6752	Jalisco	0.5246	20
21	Jalisco	0.6772	Sonora	0.5256	21
22	Quintana Roo	0.6798	Tamaulipas	0.5280	22
23	Sinaloa	0.6817	Colima	0.5428	23
24	Mˇxico	0.6824	Quintana Roo	0.5438	24
25	Sonora	0.6853	Sinaloa	0.5472	25
26	Colima	0.6884	Campeche	0.5473	26
27	Coahuila	0.6957	Coahuila	0.5637	27
28	Aguascalientes	0.7001	Nuevo Le—n	0.5783	28
29	Nuevo Le—n	0.7021	Baja California Sur	0.5787	29
30	Baja California Sur	0.7038	Aguascalientes	0.5811	30
31	Baja California	0.7176	Baja California	0.6150	31
32	Distrito Federal	0.7403	Distrito Federal	0.6376	32

Source: Authors« calculations using the Mexican Census 2000 sample.

IHDI

Will focus on H_1 as our key IHDI

$$H_1(D) = g(D) = g[g(x), g(y), g(z)]$$
$$= g[g(x), g(y), g(z)]$$
$$= g[\ \mu(x)[1-A(x)], \mu(y)[1-A(y)], \mu(z)[1-A(z)]\ ]$$

where $A(x) = 1 - g(x)/\mu(x)$ etc is a transform of Theil's second

IHDI

- Interesting measurement properties
  - Individual Scale Invariance
    - Changing scale of a single variable preserves ranks
    - And percentage changes
  - Independence of Standardized Values
    - Normalize to one country's achievements
    - Preserves ranks and percentage changes
  - Consistency over Time

IHDI

A second index H_1*

$H_1*(D) = H_1(D^*) = g[\mu(x), \mu(y), \mu(z)]$

Contrast with

$H_1(D) = g[\mu(x)[1-A(x)], \mu(y)[1-A(y)], \mu(z)[1-A(z)]]$

Idea

- H_1* is highest possible level of H_ε when one can freely transfer achievements across achievements
  = Potential H_1

IHDI

A reinterpretation

$\ln H_1(D) = \mu [\ln g(x), \ln g(y), \ln g(z)]$

$\ln H_1^*(D) = \mu [\ln \mu(x), \ln \mu(y), \ln \mu(z)]$

Traditional HDI

$H_T(D) = \mu [\ln \mu(x), \mu(y), \mu(z)]$