

Construction d'un indicateur composite pour mesurer la performance des systèmes éducatifs

based on *"International Differences in Educational Equity: An Assessment Using the Benefit of the Doubt Model"*

Giovanna D'Inverno

joint work with Cristina Polo, Rosa Simancas and Gabriela Sicilia

University of Pisa, KU Leuven



Changer de modèles?

Séminaire Maths et société – 27/28 juin 2024 – Bruxelles

Motivation

*“Not everyone can do well at school, but the **goal of equity in education is to ensure that as many as possible do so**” (Field *te al.*, 2007).*

- For a more equitable society, inclusive and fair education:
 - **Inclusion**: a basic minimum standard of education for all
 - **Fairness**: social background no barrier to outcomes
- Educational equity at the top of the agenda of education authorities worldwide and a relevant social challenges
 - right to education
 - better life chances of individuals
 - lower long-term costs of educational failure
 - better social cohesion and trust

Motivation (cont'd)

- International evidence reveals notable differences across educational systems (countries/regions)
- Multidimensional problem:
 - Results differ substantively and qualitatively according to the dimension and used indicators
 - Difficult to get a global idea or draw general conclusions about the performance of each educational system or the evolution

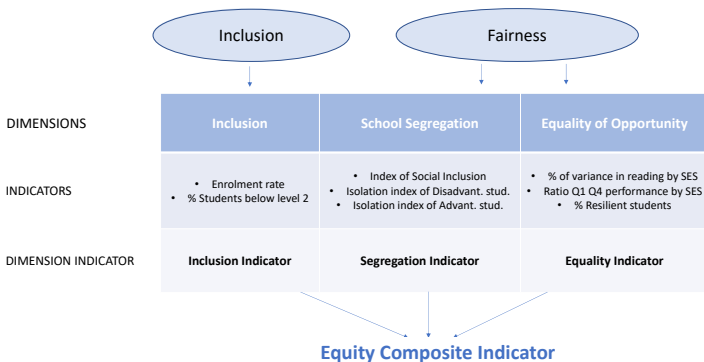


A proper evaluation and comparison of performances in terms of equity require aggregating individual indicators!

Research questions

- How to compare the performance across countries in terms of educational equity based on a single index, without losing its multidimensional nature?
- Which are the differences across OECD education systems (countries and regions) in terms of equity?
- Which are the implications in terms of educational policies?

Equity dimensions and indicators (Field et al. 2007; Cameron et al., 2018)



- Data from PISA 2018 report
- 60 educational systems: 34 OECD countries, 9 Canadian and 17 Spanish regions

Equity dimensions and indicators

- **Inclusion**: guarantee universal access and ensure all students reach a minimum standard of proficiency
 - Enrolment rate; % of students below level 2 in reading (PISA)
- **Segregation**: students with similar socioeconomic background are concentrated in certain schools
 - Isolation index of disadvantaged (advantaged) students
- **Equality of opportunity**: students' success depends on their effort and abilities, but not on their circumstances
 - % of variance in reading explained by SES; gap in educational poor students' between Q1 and Q4 in terms of SES; % of resilient

Descriptive statistics

Dimension / Indicator	Obs	Mean	SD	Min	Max
Inclusion					
% of 15-year-old enrolled students	60	96.17	4.83	75.38	100
% Students below level 2 at reading	60	21.50	6.99	10.96	49.72
School Segregation					
Index of Social Inclusion	60	79.08	7.86	56.30	93.00
Isolation index of Disadvant. stud.	60	0.15	0.05	0.08	0.27
Isolation index of Advant. stud.	60	0.17	0.06	0.07	0.37
Equality of opportunities					
% of variance in reading explained by SES	60	10.37	3.75	4.03	19.06
Ratio of % low achievers in Q1 and Q4 by SES	60	3.33	0.91	1.91	5.99
% Resilient students	60	12.71	2.58	7.24	20.50
Contextual variables					
Gini index (Income inequality)	60	32.82	4.90	23.20	49.70
% of population with tertiary education	60	38.04	10.23	17.40	63.00
Unemployment rate	60	9.52	5.79	2.90	26.40

The BoD model - Intuition

- PROBLEM: **several sub-indicators** and no a priori understanding of their importance
- SOLUTION: **a composite indicator (CI)** that aggregates sub-indicators

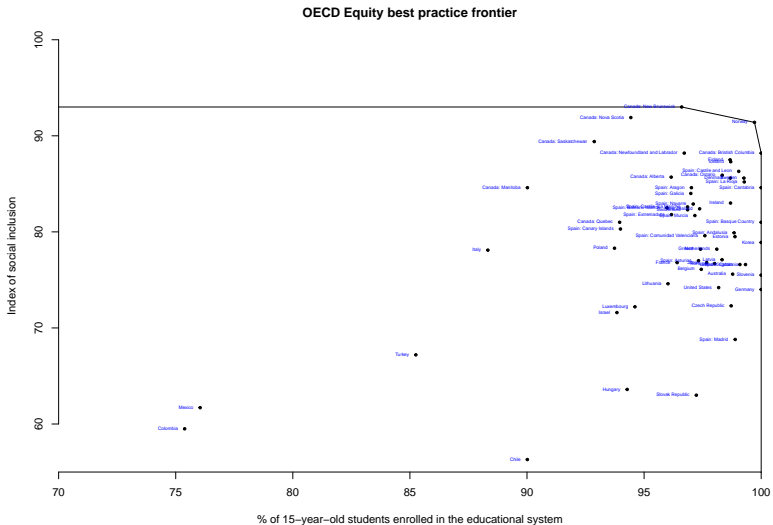
How to aggregate? How to determine the weights?

→ **Benefit of the Doubt (BoD)** model (Cherchye et al., 2007)

- data-oriented method for weights to maximize CI-value
- each unit evaluated into a relative perspective
- weights assigned to maximize the impact of performance indicators of relative strength and minimize relative weakness

To grant the unit the “benefit of the doubt” in the specification of the importance weights (any other weighting scheme would worsen the aggregate score)

The BoD model - 2D Graphical example



The BoD model

- Benefit-of-the-Doubt (BoD) weighting technique rooted in the DEA model
- Weights are obtained by solving the following problem:

$$\begin{aligned} CI_{j_0} &= \max && \sum_{r=1}^s y_{rj_0} w_{rj_0} \\ \text{s.t.} &&& \sum_{r=1}^s y_{rj} w_{rj_0} \leq 1, && \text{for } j = 1, \dots, j_0, \dots, n \\ &&& w_{rj_0} \geq 0, && \text{for } r = 1, \dots, s \end{aligned}$$

- To avoid zero weights, assurance region type I (ARI) weight restrictions (Oliveira et al., 2019)

The directional distance BoD model

- To include “undesirable” indicators (e.g. segregation) we follow the approach of Zanella et. al (2015)
- It allow to simultaneously contract the undesirable and expand the desirable indicators along the specific vector $g = (-g_b, g_y)$:

$$\begin{aligned} \max \quad & \beta_{j_0} \\ \text{s.t.} \quad & \sum_{j=1}^n b_{kj} \lambda_j \leq b_{kj_0} - \beta g_b, \quad \text{for } k = 1, \dots, l, \\ & \sum_{j=1}^n y_{rj} \lambda_j \geq y_{rj_0} + \beta g_y, \quad \text{for } r = 1, \dots, s, \\ & \sum_{j=1}^n \lambda_j = 1 \\ & \lambda_j \geq 0, \quad \text{for } j = 1, \dots, n \end{aligned}$$

β_{j_0} is the optimal value for the educational system j_0 under analysis

The robust directional distance BoD model

- We choose $g = (-b_{kj_0}, y_{rj_0})$
 - Each evaluated educational systems follows its own specific path for improvements
 - Proportional interpretation of the improvements
- The composite indicator is obtained as:

$$0 \leq CI_{j_0} = 1 / (1 + \beta_{j_0}) \leq 1$$

- We compute the **robust** version of the CI by performing a MC algorithm with B computation rounds, where in each b round a sub-sample of m units is drawn with replacement
- The robust CI is obtained as the average as follows:

$$CI_{j_0}^m = \frac{1}{B} \sum_{b=1}^B CI_{j_0}^{b,m}$$

The robust and conditional directional BoD model

- We adjust the CI to account for differences in the **operating context** of the evaluated educational systems
- These factors are not under the control of educational policymakers and could affect the attainable set of each country
- We restrict the reference set to m educational systems drawn with replacement using a probability of similarity based on an estimated kernel density function:

$$CI_{j_0}^{m,z} = \frac{1}{B} \sum_{b=1}^B CI_{j_0}^{b,m,z}$$

Empirical strategy

- We compute an individual CI for each dimension: inclusion, school segregation, equality of opportunities
- and then we average them to obtain the Equity Composite Indicator (ECI)
- We estimate two specifications:
 - Robust unconditional DD-BoD model
 - Robust conditional DD-BoD model

Empirical results - Robust DD BoD model

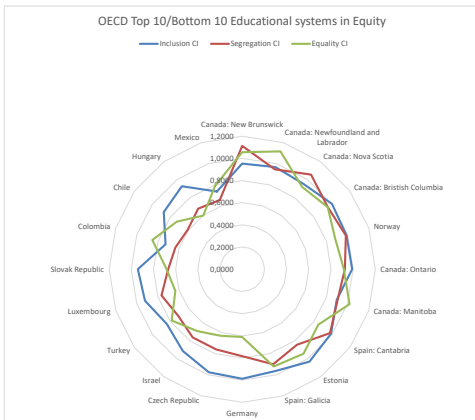
Which areas need to be mostly improved?

→ Descriptive statistics

	CI_inclusion	CI_segregation	CI_equality	ECI
Average	0.953	0.848	0.787	0.862
St. Dev	0.053	0.095	0.116	0.069
Min	0.727	0.607	0.598	0.728
Q1	0.944	0.806	0.705	0.814
Q2	0.964	0.847	0.768	0.861
Q3	0.982	0.909	0.857	0.912
Max	1.030	1.113	1.118	1.041

- The main room for improvement is the equality dimension
- Differences across education systems are remarkable

Empirical results - A closer look



- Regions from Canada and Spain and the Nordic countries outperform in terms of ECI
- Least developed countries (LAC) have the most inequitable

Empirical results

Which dimension mostly drives the Equity Composite Indicator?

→ Correlation

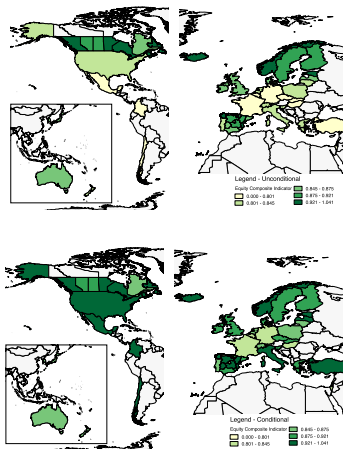
	CI_inclusion	CI_segregation	CI_equality	ECI
CI_inclusion	1.000			
CI_segregation	0.5168	1.000		
CI_EOp	-0.0141	0.5446	1.000	
ECI	0.4882	0.9023	0.8115	1.000

- The Equity Composite Indicator (ECI) is closer to segregation and equality Index
- The three dimensions are complementary

Empirical results - Conditional model

	Unconditional ECI	Conditional ECI
Average	0.862	0.907
St. Dev	0.069	0.053
Min	0.728	0.794
Q1	0.813	0.866
Q2	0.861	0.908
Q3	0.913	0.950
Max	1.041	0.998

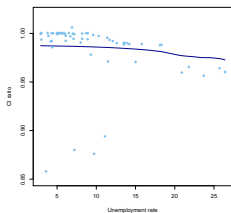
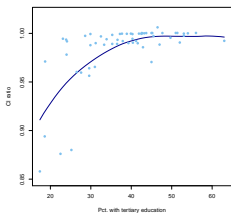
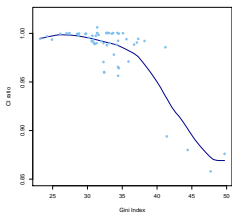
- Least developed countries are the most penalized countries by the context



The role of the context

What is the context role w.r.t. the educational systems' equity?

→ Partial regression plot (unconditional over conditional CI)



- **Income inequality** reflects significant disparities in educational achievement and in turn lower social mobility (OECD, 2018; Volante et al, 2019)
- **Share of the population that attains tertiary** levels of education positively correlates with equity (Palomino et al., 2019)
- **Unemployment rate** shows a “discouraged student effect” in inclusion (Tumino and Taylor, 2013; Lavrijsen and Nicaise, 2015)

Final remarks

- We provide a methodology that allows carrying out a comprehensive and fair comparison of the degree of equity of the OECD educational systems
- We confirm the multidimensional nature of educational equity, all dimensions should be consider simultaneously
- For some countries it is crucial to account for their operating context

