

The Sustainable Development Oxymoron: Quantifying and Modelling the Incompatibility of Sustainable Development Goals

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Sustainable Development Goals (SDG)

GOAL 1 **END POVERTY**

GOAL 2 **END HUNGER**

GOAL 3 **WELL-BEING**

GOAL 4 **QUALITY EDUCATION**

GOAL 5 **GENDER EQUALITY**

GOAL 6 **WATER AND SANITATION FOR ALL**

GOAL 7 **AFFORDABLE AND SUSTAINABLE ENERGY**

GOAL 8 **DECENT WORK FOR ALL**

GOAL 9 **TECHNOLOGY TO BENEFIT ALL**

GOAL 10 **REDUCE INEQUALITY**

GOAL 11 **SAFE CITIES AND COMMUNITIES**

GOAL 12 **RESPONSIBLE CONSUMPTION BY ALL**

GOAL 13 **STOP CLIMATE CHANGE**

GOAL 14 **PROTECT THE OCEAN**

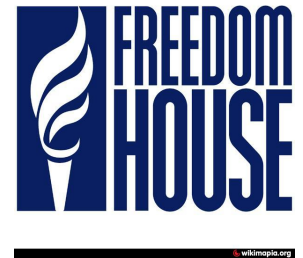
GOAL 15 **TAKE CARE OF THE EARTH**

GOAL 16 **LIVE IN PEACE**

GOAL 17 **MECHANISMS AND PARTNERSHIPS TO REACH THE GOALS**

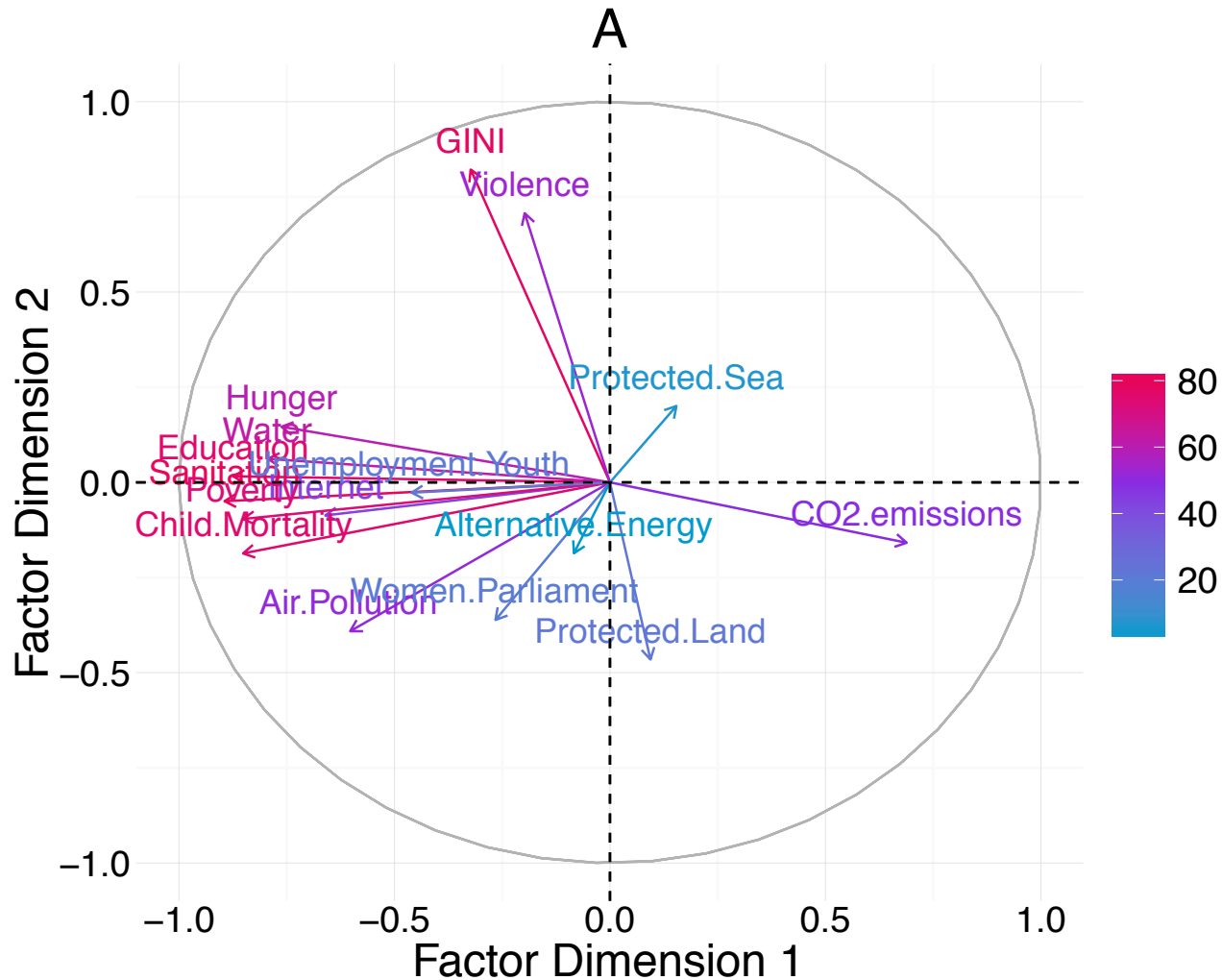


Data (Revolution) for SDGs



1432 economic, social, political and environmental indicators,
217 countries, years 1980-2013,
finally used 233 indicators

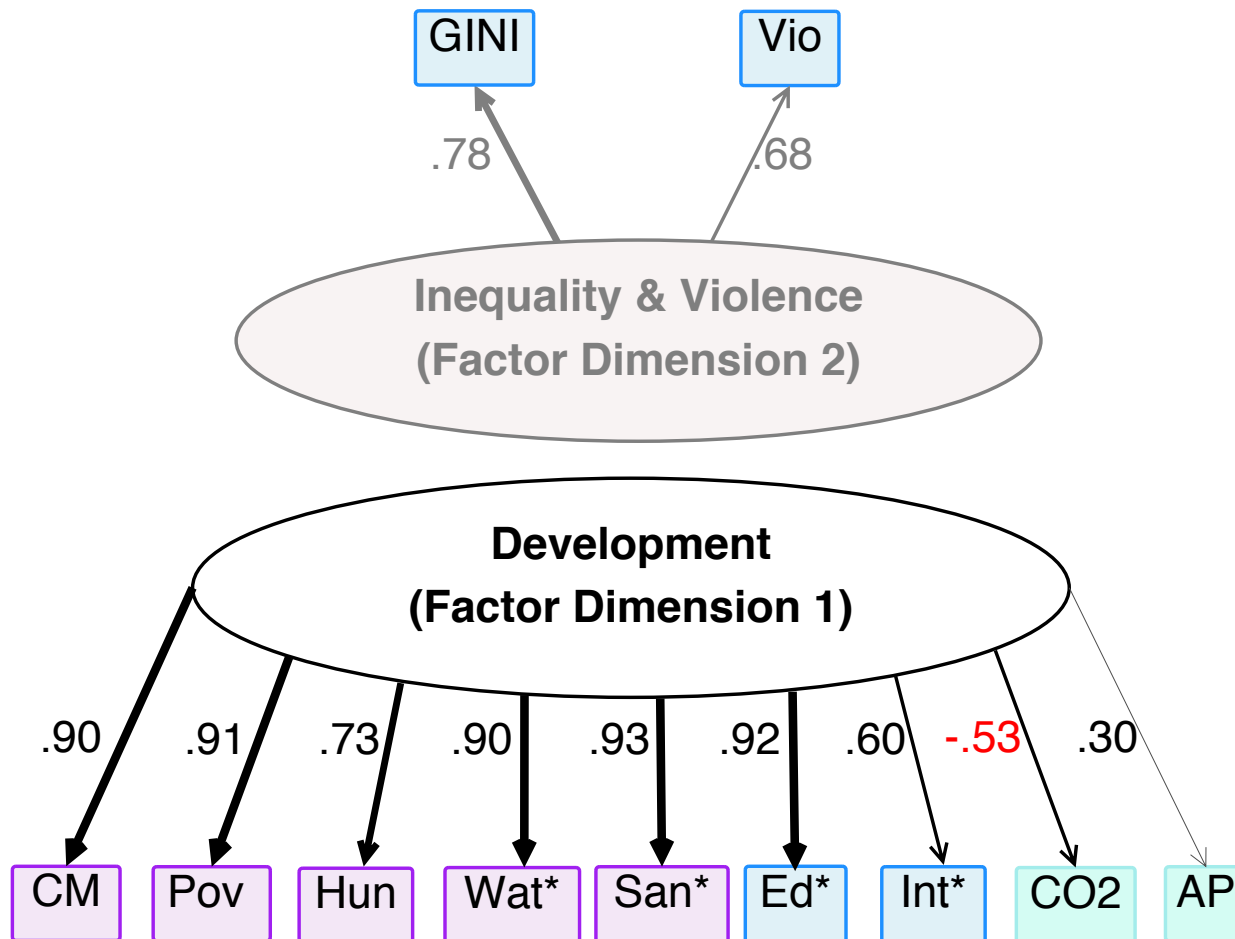
Are SDGs consistent?



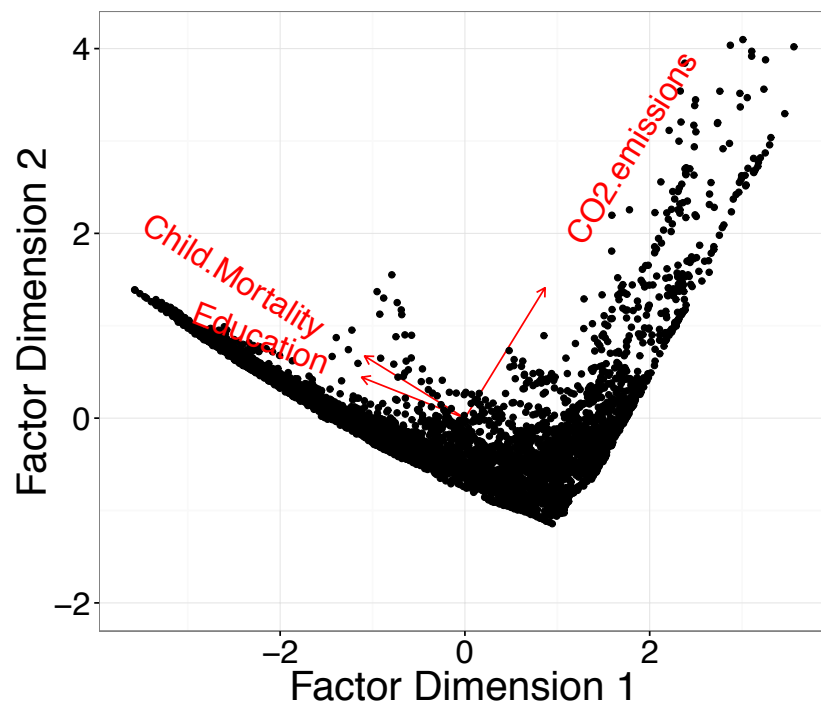
Are SDGs consistent?

EFA-suggested model, CFA confirmed:

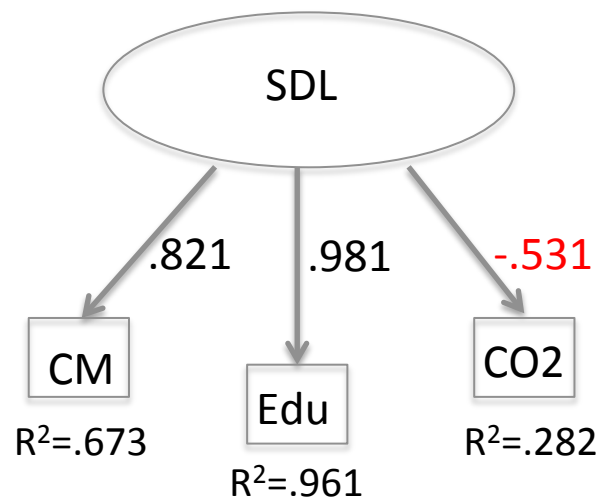
B



Model Latent Variable (L), by CFA



Proportion Variance: .73



Model Fits CFA: CFI: .973; TLI: .931;
RMSEA: .031; SRMR: .063

CFA factor scores for L used to create Model Latent Variable L (Latent Variable 1)

Finding predictive models

Method

1. Feature Selection:

Variable Elimination Algorithm, using Ensemble PLS, accounting for nonlinearities → best predictors

2. Data-driven Dynamical Systems Modeling:

Model Combination Approach & Bayesian Model Selection with best predictors selected by Feature Selection Algorithm, iterative

Data-driven Dynamical Systems Modeling



Model Selection:

1. Log Likelihood (pre-selection):

$$L(m) = \log P(dx|x, y, m, \phi_m^*)$$

2. Bayes Factor (final selection):

$$B(m) = \int_{\phi_m} P(dx|x, y, m, \phi_m^*) \pi(\phi_m) d\phi_m$$

at higher order iteration steps
only Bayes Factor

$$\begin{aligned} \frac{dx}{dt} = f(x, y) = & a_0 + \frac{a_1}{x} + \frac{a_2}{y} + a_3x + a_4y + \frac{a_5}{xy} + \frac{a_6y}{x} + \frac{a_7x}{y} + \\ & + a_8xy + a_9x^2 + a_{10}y^2 + \frac{a_{11}}{x^2} + \frac{a_{12}}{y^2} + a_{13}x^3 + a_{14}y^3 + \\ & + \frac{a_{15}}{x^3} + \frac{a_{16}}{y^3} \end{aligned}$$

Model Combination Approach:

Combination of increasing
complexity (number of terms)
of polynomial terms

Best-fit Models for change of L

$$0.46 \frac{D}{G} + 0.002G^3 - 0.02G^2 - 0.01DF_r - 0.06 \frac{R_f}{J} - 0.002N_d^2$$

D : Net foreign assets (indebtedness)

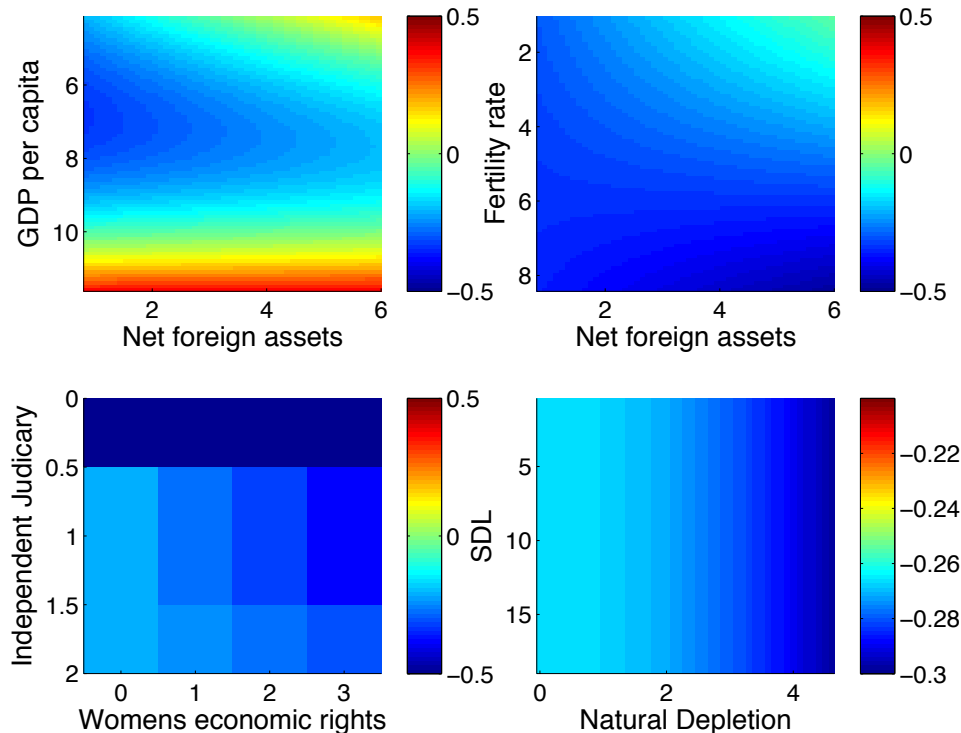
F_r : Fertility rate

J : Independence of Judiciary

G : GDP per capita

R_f : Women's economic rights

N_d : Natural depletion costs



Factors contributing to incompatibility

Factors showing a way out

Dynamical Systems Models for the three pillars

1. End Poverty (Model for changes in Child Mortality):

$$-0.03T_fG + 0.86M - 6.4\frac{M}{G} - 0.001F_r^3.$$

2. Socio-economic inclusion (Model for changes in Education):

$$-0.01G - 0.03W_g^2 + 0.001CG + 0.16\frac{W_g}{C}.$$

3. Environment (Model for changes in CO2 emissions):

$$0.00002\frac{N_d}{E_r} - 0.0004G^3 + 0.11GE_m - 0.11CE_m + 0.004GC - 0.003\frac{C}{E_m}.$$

G : GDP per capita

F_r : Fertility rate

M : Measles immunisation

W_g : Government spending

C : Final consumption expenditure

E_r : Renewable energy production

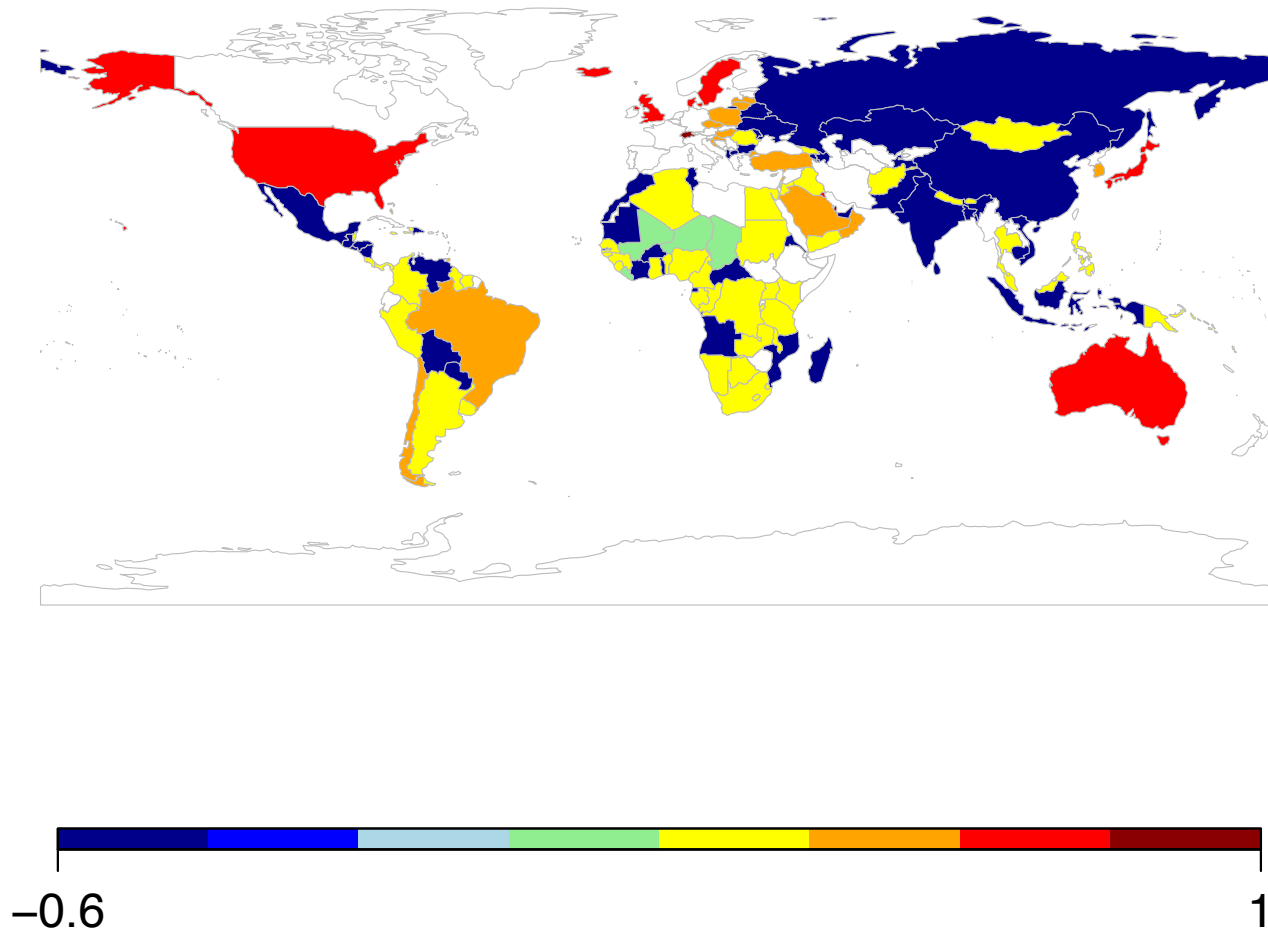
N_d : Natural depletion costs

E_m : Particulate emission damage

Monitoring Sustainable Development

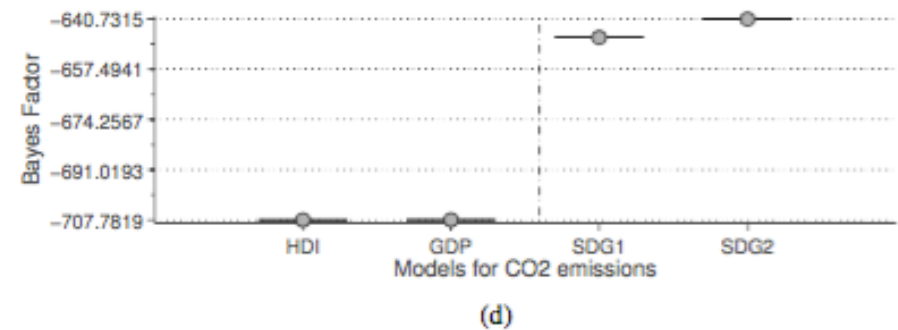
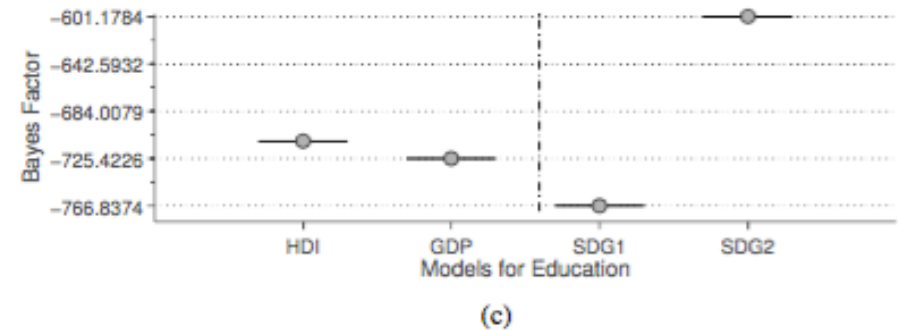
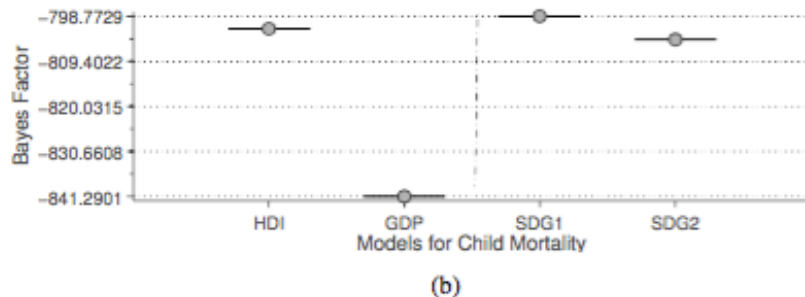
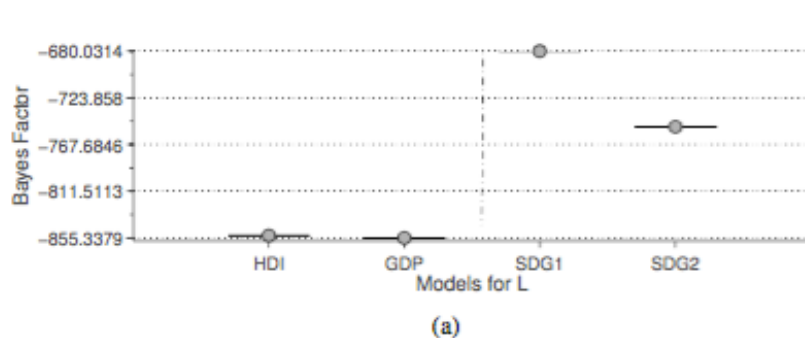
SDG index 1

Based on L model



The SDG index vs. HDI and GDP

SDG index 1 predicts	HDI predicts	GDP per capita predicts
54% of changes in child mortality	41% of changes in child mortality	17% of changes in child mortality
6% of changes in education	4% of changes in education	2% of changes in education
21% of changes in CO2 emissions	0.7% of changes in CO2 emissions	0.4 % of changes in CO2 emissions
16% of changes in L	7% of changes in L	4% of changes in L



For more information...

Working Paper on SSRN:

http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2766875