Composite indicators of well-being: the relative importance of weights

Stefano Tarantola
(JRC)
&
Elena Giachin Ricca
(University of Rome Tor Vergata)

Florence, 10 September 2011

http://easu.jrc.ec.europa.eu/

- Explore the feasibility to developing composite indicators by using both objective and subjective information.

- Beyond the standard way to aggregate indicators we test an approach in which the weights are derived from a regression model linking life satisfaction individual data with the underlying indicators

- Our test case at EU level: the institutional set of indicators of sustainability (European Strategy for Sustainable Development - EU SDS).

- The aim is not to find the perfect link btw life satisfaction and the SDS indicators, but to see how much EU citizens share with their policy-makers the same concerns in terms of WB. This is important if we want to build a synthetic measure of WB.

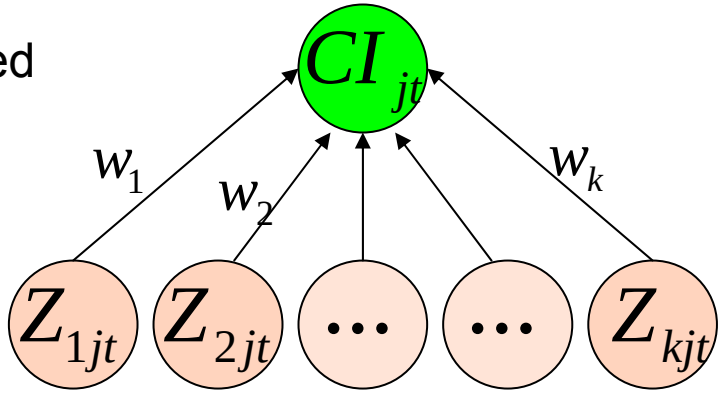
Composite indicators are mainstream tools for benchmarking (and ranking) individuals, universities, firms, cities, nations,…

Composite indicators of well-being (or sustainable development).
In a traditional approach we aggregate a number of suitably-chosen indicators.
Here we use the headline indicators of the EU SDS.

Subjective weights w_i are provided by stakeholders.

A number of aggregation rules can be applied from compensatory (eg linear) to non compensatory (eg Copeland scores)

Resulting composite scores are of good quality if they depend mostly on the underlying SD indicators and less on the weights (sensitivity analysis).



j=country
t=time

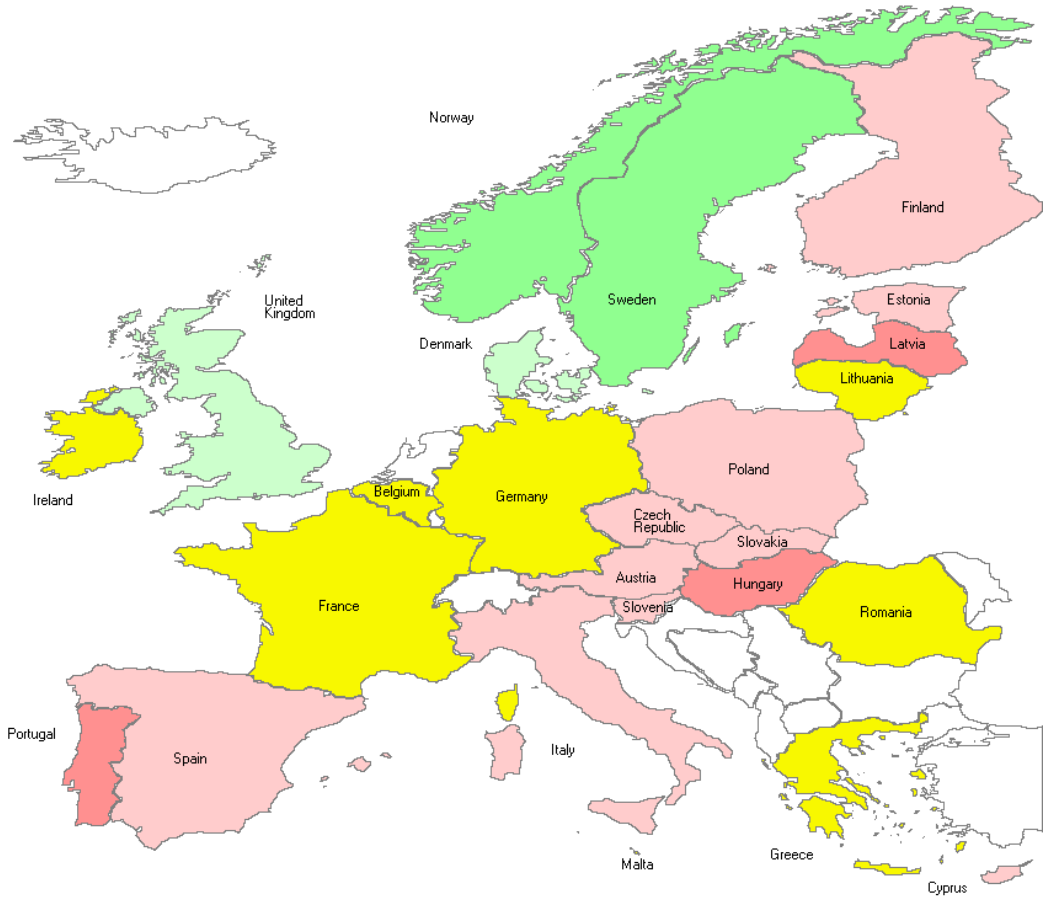
The set of indicators of the European Strategy for Sustainable Development (EU SDS).

Indicators cover key areas of intervention

SDS objectives	**Headline Indicator**	**Variable**
Social inclusion	Population at risk of poverty or exclusion	Risk of Poverty
Natural resources	The common bird index (index base year = 100)	Biodiversity
Demographic changes	employment rate of workers aged 55-64	Employment rate of older workers
Sustainable transport	Energy consumption of transport as % of GDP	Energy consumption in transport
Climate change	Greenhouse gas emissions (index base year =100)	Green-house Gas emissions
Global partnership	Official development assistance as share of GNI	Official Development Aid
Sustainable consumption	GDP / Domestic Material Consumption	Resources' productivity
Energy	Share of renewables in gross final energy consumption	Use of renewable energy
Public health	Healthy life years and life expectancy at birth	Life expectancy
Socio-economic development	Growth rate of real GDP / cap (%)	GDP growth rate

Standard composite indicator:
min-max transformation, equal weights
linear aggregation

Headline Index



Sweden	706
United Kingdom	668
Norway	664
Denmark	548
Germany	518
France	511
Lithuania	504
Malta	501
Romania	500
Belgium	497
Greece	481
Ireland	437
Cyprus	424
Slovakia	424
Slovenia	417
Finland	411
Poland	407
Czech Republic	405
Estonia	400
Spain	393
Italy	391
Austria	385
Latvia	354
Portugal	351
Hungary	311

Micro econometric regression model with life satisfaction data.
Estimate coefficients gamma and from those determine weights

Socio-demographic characteristics

SD headline indicators

$$LS_{ijt} = \alpha + X_{ijt}\beta + Z_{1jt}\gamma_1 + Z_{2jt}\gamma_2 + \ldots + Z_{kjt}\gamma_k + \varepsilon_j + \tau_t + \lambda_{ijt}$$

$$WB_{jt} = Z'_{jt}\hat{\gamma}$$

i= individual
j=country
t=time

Country fixed effects are estimated such that country-specific cultural and institutional features do not affect the estimation of gamma.
Year fixed effects to capture any global shocks that are common to all countries in a given year.

Much literature available in economics …

• Diener and Suh (1997) argue that subjective well-being measures and social indicators are necessary to evaluate a society and add substantial information to the economic indicators. Diener and Seligman (2004) stress some beyond-monetary indicators which influence national well-being: governance, social capital, religion.

• Easterlin and Angelescu (2007) analyze countries at different level of development, put forth evidence for the high and positive correlation between a series of “quality of life” indicators such as happiness, material living conditions, health, education, civil rights and GDP per capita.

• Helliwell (2003) brings arguments in favor of using life satisfaction as a way to evaluate the quality of a society. By using the World Values Survey, he combines individual and societal variables so to assess the effect of individual and national income (GDP), the average level of interpersonal trust, the quality of institutions and life expectancy rate (measuring public health) on citizens' WB.

Overview of the literature (cont.)

A number of papers in the Economics of Subjective Well - Being have tried to merge the micro perspective of the individual determinants of life satisfaction (as being unemployed) with the macro perspective by including aggregate variables (as the unemployment rate).

•Frey and Stutzer (2000) differentiate three set of explanatory variables for SWB: i) personality and demographic factors; ii) micro and macro factors; iii) institutional conditions of a society. They use this approach to study the influence that institutions of direct democracy have on SWB of Swiss citizens.

•Di Tella, MacCulloch and Oswald (2003) in «Macroeconomics of Happiness» show that macroeconomic forces such as GDP growth, unemployment and inflation rate have statistically significant effects on reported well-being in 12 European countries and the United States.

•Sharpe, Ghanghro, Johnson, Kidwai (2010) Centre for the Study of Living Standards, show that household income is a relatively weak determinant of individual happiness of Canadians.

Overview of the literature (cont.)

- Alesina, Di Tella and Mac Culloch (2004) analyze the influence of inequality over life satisfaction in two “cultural samples” of European and American citizens. Controlling for individual income and other personal characteristics as well as for year and country dummies, they focus on inequality as measured by Gini coefficient. They find that individuals have a lower tendency to report themselves happy when inequality is high and this is particularly true in Europe.

- Becchetti, Castriota and Giuntella (2009) test whether the inflation/unemployment trade-off changes according to age and the national degree of employment protection. Using the Eurobarometer survey, they document that the cost of unemployment as perceived by European citizens is markedly higher in central age classes and in countries with lower employment protection with respect to the perceived cost of inflation.

- Eurobarometer survey (cross section): 1973 - 2009
- Question: “on the whole are you very satisfied, fairly satisfied, not very satisfied or not at all satisfied with the life you lead? 1= not at all satisfied to 4 = very satisfied.
- As the EU SDS are not available for all the waves, we limit our empirical exercise to the following
  - Years: 1998, 1999, 2000, 2001
  - Countries: France, Belgium, Germany, Italy, Denmark, Ireland, UK, Spain, Sweden, Austria, Cyprus
- No. of individual observations: 67,077

$$LS_{ijt} = \alpha + X'_{ijt}\beta + Z_{1jt}\gamma_1 + Z_{2jt}\gamma_2 + \ldots + Z_{kjt}\gamma_k + \varepsilon_j + \tau_t + \lambda_{ijt}$$

i= individual
j=country
t=time

- Set of explanatory variables at individual level: Gender, Age, Level of Education, Household size, Marital Status, Occupational status, Income
- Set of explanatory variables at macro level: unemployment rate, inflation rate, Gross Disposable Income per capita + EU SDS

$$LS_{ijt} = \alpha + X'_{ijt}\beta + Z_{1jt}\gamma_1 + Z_{2jt}\gamma_2 + \ldots + Z_{kjt}\gamma_k + \varepsilon_j + \tau_t + \lambda_{ijt}$$

- Country and year fixed effects are included in the model so that the coefficients gamma capture the portion of LS commonly shared by EU citizens without including country-specific and time specific effects.
- The categorical nature of the LS data is dealt with by an ordered logit model. The regression coefficients gamma are used to estimate marginal effects.

Marginal effects: probability to reach the highest level of life satisfaction for an increase of one unit in variable Z

Household Income	0.0175***	0.0176***			
Unemployment rate	-0.0257***	-0.0129	-0.0238**	-0.00847	
Inflation rate	-0.00475***	0.00144	-0.00275	0.00408**	
Gross Disposable Income	0.0625***		0.0723***		
Risk of Poverty	-0.0695***	-0.138***	-0.0952***	-0.169***	-0.0970**
Biodiversity	0.0114	-0.0532***	0.0128	-0.0623***	-0.0403***
Employment rate of elders	-0.0843	0.181***	-0.0459	0.253***	0.198***
Energy consumption in transpo	-0.0280***	-0.0256***	-0.0266***	-0.0238***	-0.0272***
Green-house Gas emissions	0.0423	0.151***	0.0847*	0.212***	0.179***
Official Development Aid	-0.0464**	-0.0954***	-0.0698***	-0.120***	-0.0844***
Sustainable consumption	-0.00668	-0.0227	0.0267	0.00375	-0.0572
Use of renewable energy	-0.0744*	-0.00535	-0.0326	0.0517	-0.0309
Life expectancy	0.207***	0.495***	0.287***	0.624***	0.516***
GDP growth rate	0.0269***	0.0247*	0.0208**	0.0238	0.0418**

legend: * p<0.05; ** p<0.01; *** p<0.001

Alternative models show consistent coefficients. We select the regression with most significant coefficients

Four indicators have relatively high coefficients

Two indicators are statistically non significant

Negative coefficients: swap the direction of the indicators before aggregation.

Weird sign for Official development aid, Biodiversity and GH gas emissions.

Weights: coefficients are taken in absolute value and normalised to sum to one

$$WB_{jt} = Z'_{jt} w(\hat{\gamma})$$

indicators	weights
Risk of Poverty	**0.12**
Biodiversity	0.04
Employment rate of elders	**0.17**
Energy consumption in transport	0.01
Green-house Gas emissions	**0.14**
Official Development Aid	0.08
Sustainable consumption	0
Use of renewable energy	0
Life expectancy	**0.42**
GDP growth rate	0.01

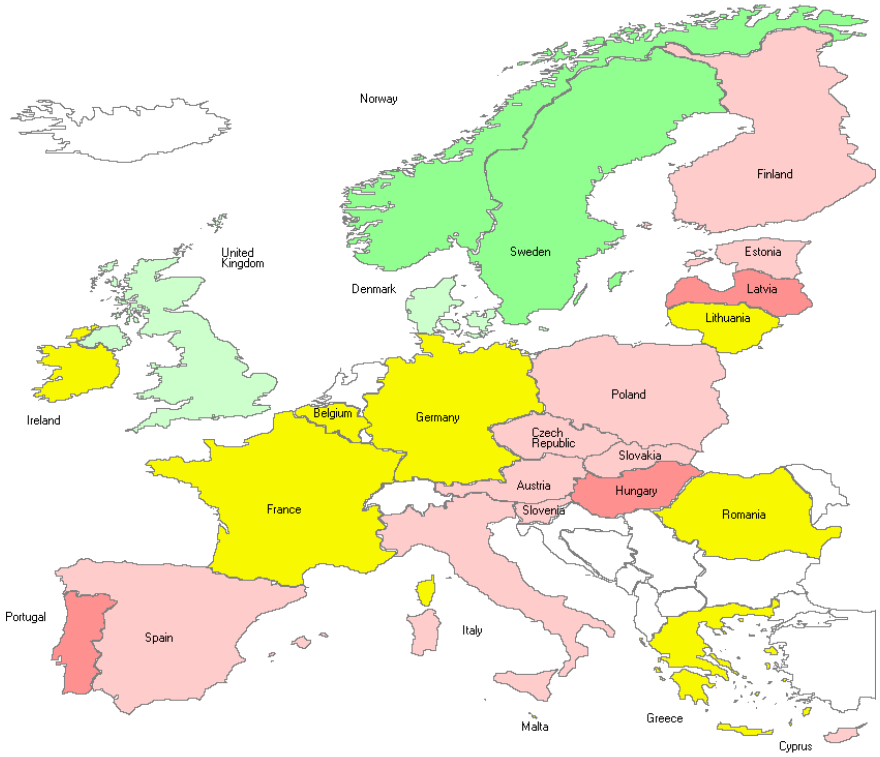
4 out of 10 SD indicators have significant weight.

2 indicators are not included in the evaluation of the CI

Other indicators could be proposed and the model re-estimated to expect high coefficients for a larger set of indicators.

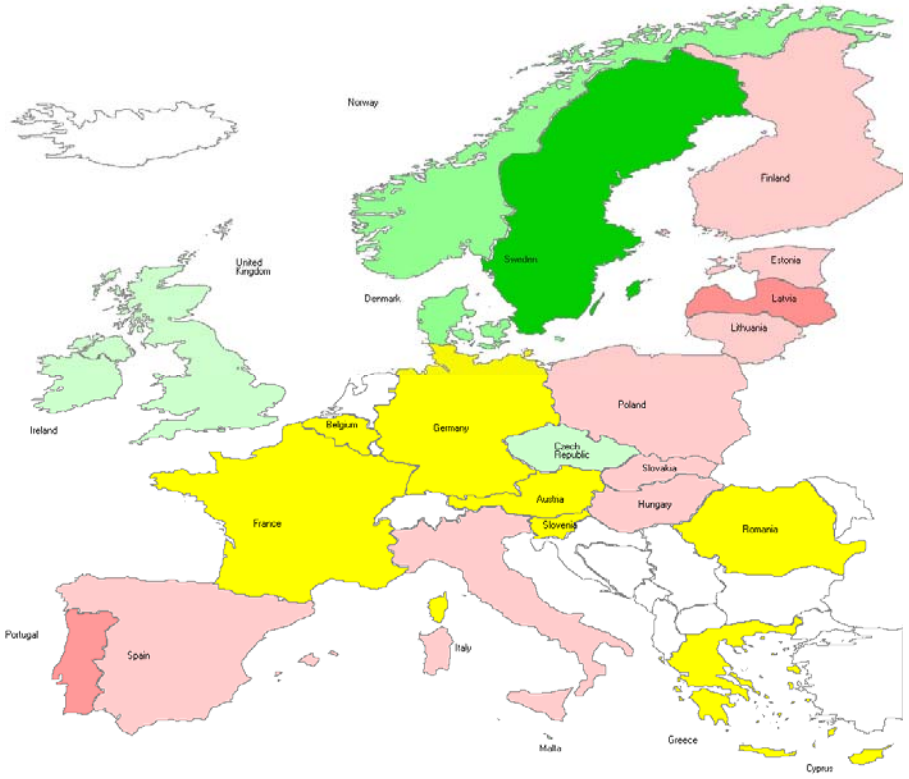
Headline Index

Equal weights

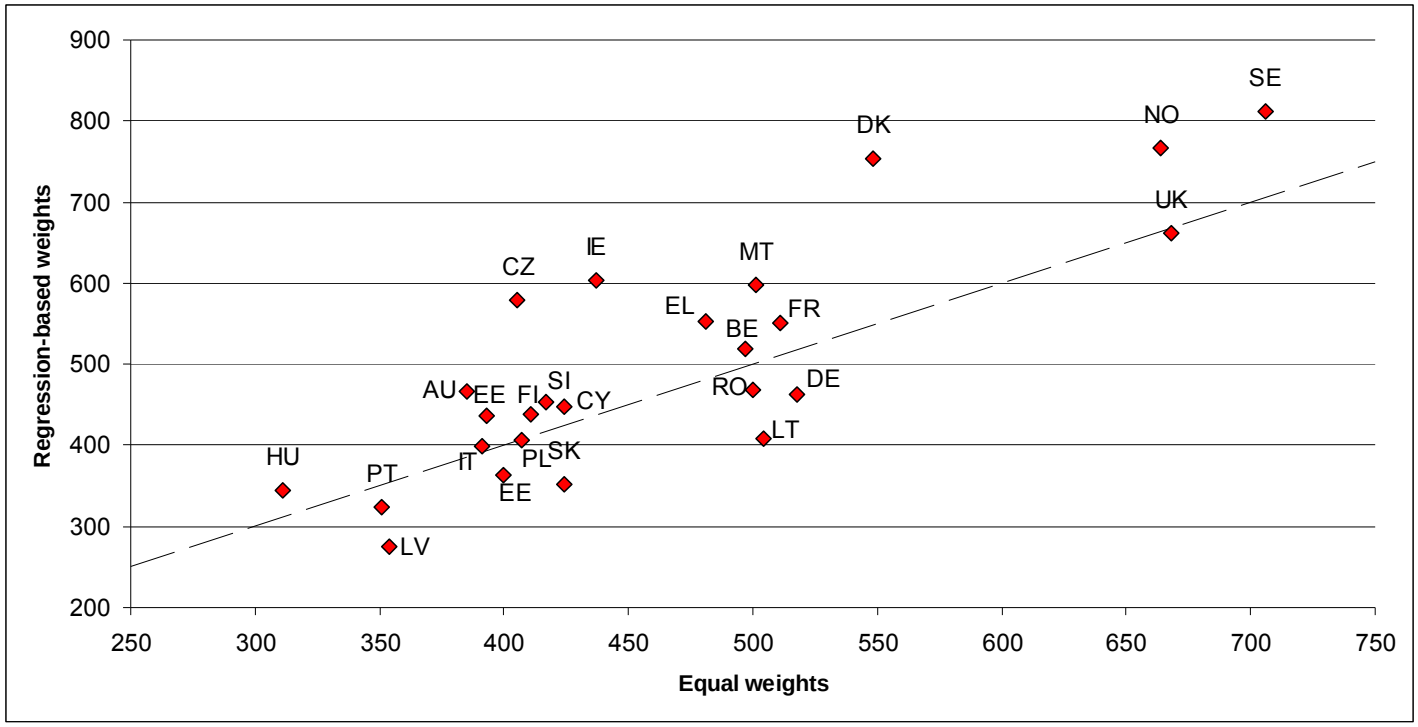


Headline Index

Regression-based weights



Green = top performance
Red = bad performance



_ _ _ 45 degree line

The CI scores (on a range 0 – 1,000) are generally higher for regression-based weights. For some countries the ranking can change considerably (see eg Ireland and CZ). Other countries are neutral to change of weights

Consider this as the result of a research exercise to contribute to the discussion on the relative merits of alternative approaches.

Sample is split according to high/low income and age group

Coefficients look consistent.

	high income	low income	young	old	whole sample
Risk of Poverty	-0.221***	-0.127***	-0.172***	-0.165**	-0.169***
Biodiversity	-0.0585***	-0.0855***	-0.0510***	-0.104**	-0.0623***
Employment rate of elders	0.365***	0.106*	0.270***	0.200	0.253***
Energy consumption in transport	-0.0219***	-0.0236***	-0.0236***	-0.0266*	-0.0238***
Green-house Gas emissions	0.219***	0.233***	0.182***	0.334***	0.212***
Official Development Aid	-0.160***	-0.0944***	-0.106***	-0.202***	-0.120***
Sustainable consumption	0.0786*	-0.0916**	0.0158	-0.0373	0.00375
Use of renewable energy	0.0238	0.0999*	0.0976**	-0.224	0.0517
Life expectancy	0.678***	0.570***	0.629***	0.514***	0.624***
GDP growth rate	0.00734	0.0446***	0.0302**	-0.0308	0.0238

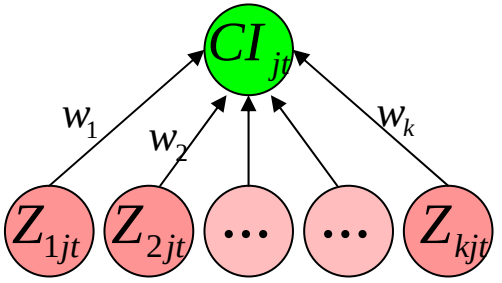
Regression model: an alternative approach to build CIs.

$$WB_{jt} = Z'_{jt} w(\hat{\gamma})$$

PROS

Subjective information on LS is an added value.

Regression approach could help seeking for the best set of indicators to be aggregated.



CONS

The regression model is a linear aggregation, while standard CI could also be constructed using non linear aggregation rules.

Coefficients are data driven and can be negative. Coefficients have to be converted to weights.

Major problem could be the collinearity within Z, between X and Z and causality between LS and Z.

Much more complex than the standard procedure

Proposed analysis:
Evaluation of the impact of SD on life satisfaction

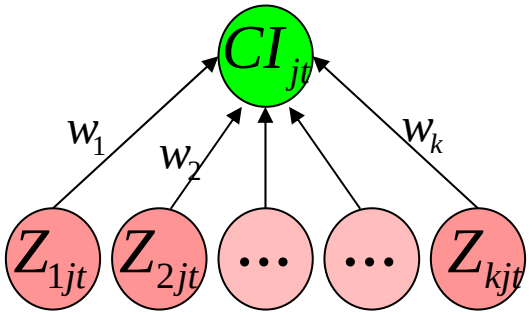
Socio-demo-economic characteristics

$$LS_{ijt} = \alpha + X'_{ijt}\beta + \delta + \varepsilon_j + \tau_t + \lambda_{ijt}$$

Construct a standard CI with given w and Z

Include it in the econometric model.

i= individual
j=country
t=time



Estimate δ, which tells us what is the amount of Life Satisfaction variance explained by the CI.

Objective: maximize δ to find the best CI structure that captures most of Life Satisfaction. Ideally we whave a CI that measures LS.

European Commission
Joint Research Centre
Institute for the Protection and Security of the Citizen

Composite Indicators

An information server on composite indicators and ranking systems

Home
FAQ
Publications
OECD/JRC Handbook
Events
Databases
Contact

Econometrics and Applied Statistics Unit

"[...] it is hard to imagine that the debate on the use of composite indicators will ever be settled [...] official statisticians may tend to resent composite indicators, whereby a lot of work in data collection and editing is "wasted" or "hidden" behind a single number of dubious significance. On the other hand, the temptation of stakeholders and practitioners to summarise complex and sometime elusive processes (e.g. sustainability, single market policy, etc.) into a single figure to benchmark country performance for policy consumption seems likewise irresistible."

Andrea Saltelli, JRC

OECD/JRC Handbook (2008)

Latest News

06/2011 The Global Innovation Index benefiting from JRC recommendations

'The Global Innovation Index 2011 (GII) – Accelerating Growth and Development' was released today (June 30, 2011) by INSEAD, one of the world's leading and largest graduate business schools. It aims at enabling countries to benchmark their policies through an integrated metric that was carefully designed in order not to penalize smaller or lower-income economies. This year the GII model includes 125 countries that represent 93.2% of the world's population and 98.0% of the world's GDP. All EU countries except Malta are represented in the ranking.

06/2011 Measuring the rule of law: the World Justice Project ranks 66 countries