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The Cost of Well-being

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Abstract

Since measures of well-being are meant to be an exercise in documentation, but also a tool for policies and priorities, we suggest an operative way to use them. We evaluate both technical and social efficiency of countries in producing the Better Life Index (BLI) objectives. To assess the efficiency test, we use Data Envelopment Analysis integrated with Principal Component Analysis. Our analysis shows that BLI increases with GDP only for poor countries, extending the Easterlin Paradox to the quality of life measurement; that good performances in BLI are not necessarily due to a high efficiency of the whole system; and that social efficiency is the best predictor of development.

JEL-Code: I310.

Keywords: Better Life Index, Data Envelopment Analysis, quality of life, GDP, welfare, well-being, social efficiency.

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1. Introduction

GDP is still by far the most widely used measure of economic performance. Reasons why this happens are at least of two kinds. First, GDP is a relatively simple measure, definitely easier to handle and to share than measures that involve qualitative indicators. Second, the assumption that 'quality results from quantity'- namely that the causal relation is from wealth to well-being and quality of life – is still significantly widespread. In sum, GDP still enucleates the core idea about the nature of economic development.

Many international organizations, on the other hand, have done a lot of work to develop measures of economic performance alternative to GDP. United Nations, to give a single example, is launching the Sustainable Development Goals, a set of international objectives to improve global well-being, and to define a 'new objective for humanity', as a summary of the existing indexes and of the research linked to them.[1]

The research on measures alternative to GDP developed very soon after the evolution of national accountability. In the 90s it became significant, but it literally burgeoned at the beginning of the new millennium.[2] The last two decades have also witnessed a new permeability of economics by other human and social sciences and, in particular, by psychology. By merging the knowledge of these disciplines, the fallacy of the *methodological individualism* based on the *homo oeconomicus* paradigm has become evident. As regard to what concerns us here, the revolutionary point is that well-being of people is no more a second step goal, coming after economic welfare, but it is itself a determinant factor of economic prosperity. Good levels of personal and social indicators such as trust, identity, self-realization, self-esteem and, more broadly speaking, quality of life, produce better levels of productivity, creativity which, in turn, yields innovation as a first spill-over effect, health and, in turn, more development and growth. As Diener has pointed out, *"desirable outcomes, even economic ones, are often caused by well-being rather than the other way around"*.[3]

Quality of life is itself a powerful growth factor, and this is a good reason for public policies to pursue it.[4] To this aim, the OECD has launched the *Better Life Index* BLI, which is a set of indicators that goes beyond both the class of corrected GDP s like the Genuine Progress Indicator, and the class of subjective well-being indicators like the measures of happiness.

The conceptual framework used by the OECD to define and measure well-being in its Better Life Initiative distinguishes between current and future well-being. Current well-being is measured in terms of outcomes achieved in the two broad domains, not hierarchically ordered Kerényi (2011): material living conditions income and wealth, jobs and earnings, housing conditions, and quality of life health status, work-life balance, education and skills, social connections, civic engagement and governance, environmental quality, personal security and life satisfaction. Future well-being is assessed by looking at some of the key resources that drive well-being over time and that are persistently affected by today's actions.[5] The OECD has conceived this set of indicators to be a web-based interactive tool useful to make international comparisons on the dimensions chosen by the analyst, also giving different weights to variables.

The Better Life Initiative has boosted a new age of data collection, as strongly recommended by the Sen-Stiglitz-Fitoussi report 2009,[6] both at the international and at the national level[7].

A quality of life measure is not meant to be an exercise in documentation, but rather is also to inform policies and priorities that balance attention among a range of valued achievements. In order to proceed in this direction, i.e. to extend the use of BLI to the normative ground, we suggest a method of aggregation, and

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[1] Costanza, R."Time to leave GDP behind", Nature, January 16, 2014.

[2] Bandura (2005, 2008), reports that the 80% of new welfare indexes available in 2005 had been developed after 2000. Bleys (2012), suggests a classification of the various indexes because, he claims, the research on them has long been concentrated on the definition of new ways to go further GDP and on the refinement of them, more than on the comparison of the existent ones.

[3] Diener et al., (2004), p.8.

[4] Quality of life and well-being are not proper synonymous: the former is usually an objective mix of quantitative and qualitative variables, while the latter is more focused on subjective indicators, both quantitative and qualitative. However, for what concerns this paper, we will use them interchangeably.

[5] Durand, Smith, (2013).

[6] BLI has still an unexpressed potentiality: time series are obviously, still to be collected and no information on distribution of resources is included yet. OECD 2011.

[7] The OECD initiative has been followed by many national data collections: See, for example, "Measuring national well-being" from the Office of National Statistics - ONS, Great Britain, 2010; BES Fair and sustainable welfare, ISTAT and CNEL, Italy; the new data collection by the Institut National de la Statistique et des Études Économiques. INSEE, France; ONS 2011; INSEE 2010.

a new way to use it. We interpret each dimension as a positive or as a negative output that each country produce. We first aggregate the 24 variables included in the 11 dimensions of the index, to get a unique quali-quantitative index. At a second stage of our work, we suggest a method to evaluate the relative efficiency of each country in producing BLI.

As BLI has negative and positive dimensions, taking BLI as output you have good and bad output of well-being. So we take in to account three kind off efficiency in its production: Global efficiency, Technical Efficiency and Social Efficiency. Where Global efficiency is the best BLI by minimum conventional resources (capital and labor), Social efficiency is the best good output with the minimum bad output (social costs, namely the amount of negative dimensions produced to get the set of good ones). Technical efficiency is the best good output with minimum conventional inputs used (capital and labor).

Data Envelopment Analysis (DEA) is the evaluation of efficiency method we choose. By this tool we can get an efficiency production frontier based on existent technologies, namely from a linear transformation of the input-output combinations used by each country. We integrate DEA with the Principal Components Analysis PCA, because we have a database with many variables 24 output variables and 2 inputs, and a few units of analysis 35 countries.

A comment on the shift on the efficiency ground is worthwhile. To introduce an efficiency criterion in a context of evaluation of the quality of life can appear bizarre o even contradictory, unless we clearly underline the difference between efficiency at the individual and at the social level. Neoclassical economics consider them tightly linked, as social efficiency results only by individual efficiency.

Happiness economics, which is the background research of the new sets of welfare indicators, shows that the quality of life is at times attainable only if technical efficiency is abandoned at the individual level. For example, good interpersonal relations may require to reduce working time even if it is costly; the protection of environment may cause longer transport times (e.g. using public transportation), it may require more time to select waste correctly, or to pay higher prices in order to buy recoverable materials, organic food, and so on.

On the other hand, technical efficiency remain a crucial issue at the level of the social system since individual quality of life depend on a careful use of collective resources to preserve both physical and social capital. A use of finite resources as efficient as possible is necessary to produce sustainable human well-being, which in turn depends on the well-being of the rest of nature.[8] Moreover, an efficient use of collective resources enhance social cohesion, participation and trust in public institutions.[9]

The paper is organized as follows. Paragraph 2 reviews the literature on Data development Analysis used to evaluate socio-economic performances, and introduces some methodological issues in the literature of Data Development Analysis: this is useful to justify the methodological choice we take in order to apply this method to the evaluation of the production of Quality of Life as measured by Better Life Index. Paragraph 3 introduces the model chosen to run our analysis. Paragraph 4 describes the data used. Paragraph 5 presents the results of our analysis.

We compare the aggregate Better Life Index for all the units of our analysis OECD countries, and we then move to the comparative analysis of global efficiency as well as of social and technical efficiency among countries. We find that after a certain threshold of GDP, aggregated BLI is not improved any more. This result is in line with the Paradox of Happiness Easterlin (1974), according to which happiness is not improved any more by a raise in GDP, after a certain level of the latter. Here, this result is extended to a more comprehensive Quality of Life measure. A similar result is achieved for global technical efficiency in producing quality of life, where we find that both lower and higher income countries manage to be efficient at producing quality of life goals, while others do not, irrespectively of the income level. A high material wellness, in other words, does not guarantee an underlying high global efficiency. High GDP countries are on average better than poorer ones only at achieving social efficiency. The last paragraph sums up.

2. Methodological issues in the literature

The use of DEA for socio-economic performance evaluation has its origins in the early 1990s. The first paper by Hashimoto, Ishikawa (1993) has been followed by works which differ in objectives, Decision Making Units (DMUs) and indicators. The DMUs, are usually Countries (Lovell *et al.* 1995) as well as Local Governments (Hashimoto, Ishikawa, 1993). The most important distinction between these works is whether or not a model uses conventional inputs. A conventional input is a standard factor of production, such as

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[8] Costanza et al. (2013), p.12.

[9] Barone, Mocetti (2011), look at how efficiency in public spending may shape individual tax morale.

capital or work, whereas social costs, even if they are often treated as input, are considered here as bad outputs[10].

Using DEA applied to socio-economic indicators, without conventional inputs in the model, allows for the aggregation of different information, without choosing the order of importance.[11] This is possible because DEA does not require any predetermined functional form to be specified, as it assigns the most favorable shadow-price to any variable incidental to efficiency. Efficiency, namely, is the capability to perform better than the others at least in one dimension (Pareto efficiency).

Using DEA with socio-economic indicators and putting conventional inputs in the model, allows one to assess the efficiency in the production of socio-economic well-being, without choosing the functional form and the shadow-prices of the variables. The efficiency, here, is the capability to have at least one good socio-economic indicators using the fewest resources.

The first theoretical problem for those who uses the DEA on socio-economic variables, is the choice of indicators that are good predictors of well-being. On this point, if in the first study (Hashimoto, Ishikawa, 1993) it was necessary to justify all the indicators chosen, the works of Mahlberg, Obersteiner, (2001), Zhu (2001) and Mizobuchi (2014) chose, respectively, the Human Development Index (HDI), "Fortune" magazine's index of quality of life, and the *Better Life Index*. The studies referred to the indexes' creators to, in turn, justify the choice of variables.

The second theoretical problem involves good selection, because a high number of indicators raises the possibility of efficient analysis units (efficiency 100 percent) that are not classifiable amongst each other. This occurs because with DEA those with at least one indicator resulting best in the group are considered efficient, therefore increasing the number of indicators increases the probability of efficiency in at least in one dimension.

To face this problem, most studies (starting from Hashimoto, Kodama, 1997) use the Assurance Region Analysis of Thompson et al. (1986). This method binds together the weights, making it possible to attribute an order of importance to the variables. One result of this choice is greater selection, because productivity has fewer dimensions (only that which is associated with the most important variables) than the original ones. In this case, however, the risk is losing the core attribute of DEA, namely, that it does not require a priori any ranking amongst variables, this being a product of the analysis, not a given analyst's assumptions. Zhu (2001) proposes an original solution, which puts on the frontier of efficiency only the three best cities selected by Fortune magazine, it is clear even in this case, however, that the results are strongly affected by the choice of the analyst.

Studies that intend to evaluate the production of socio-economic indicators on the basis of conventional input, have two more issues: the choice of factors to be taken into consideration and the unit of measurement. The choice of factors generally relies on other studies that seek the determinants (the productive base) of well-being (as Dasgupta, 2001 and Arrow et al., 2004). The unit of measurement is a purely technical problem well described in Dyson et al. (2001). The problem is that the input must be commensurable to the output, in the sense that if the output is an index (scale-independent), the input cannot be expressed as an absolute value (depending on scale), as the results are then conditioned by the size of the unit of analysis.

The first work that considered the inclusion of conventional input is that of Golany and Thore (1997). They choose a proxy capital, formed by three variables: the investments over the last 15 years and spending over the past 15 years (divided into education and other). In order to make an assessment that is not dependent on the sizes of the countries, the authors choose to divide all variables (input and output) by the GDP. Another important contribution is by Zaim et al. (2001) which, despite availing itself of a purely methodological approach, is important in that in its explanatory example the input are capital and labor, while the output are the GDP and three social indicators. The most recent contribution is by Mizobuchi (2014), who chooses as input the physical capital, natural and human, taken from the World Bank (2011), expressed in per capita values, and who chooses as outputs the BLI in the 11 dimensions proposed by OECD. The following table summarizes the analysis units and variables considered in the works cited here.

[10] Standard inputs has been put in the model by Golany, Thore (1997); Zaim et al. (2001); Mizobuchi (2014), while has been not considered by Hashimoto, Ishikawa (1993); Hashimoto, Kodama (1997); Zhu (2001); Mahlberg, Obersteiner, (2001); Ramanhatan (2006); Murias et al (2006).

[11] Lovell *et al.* (1995) use the same input for all DMUs, or Hashimoto, Ishikawa (1993) treat only bad outputs as input.

TAB. 1: *DEA literature for socio-economic performance evaluation*

Reference	**DMU**	**Inputs**	**Outputs**
Hashimoto, Ishikawa (1993)	47 prefectures of Japan	- Suicide - Crime - Traffic accidents - Unemployment	- Life expectancy - National income - Forest area - Water service
Lovell *et al.* (1995)	19 OECD Countries	- Uniform	- GDP - Uninflation - Employment - Trade balance -$(\text{Carbon})^{-1}$ -$(\text{Nitrogen})^{-1}$
Hashimoto, Kodama (1997)	Time series of Japan 1956-1990	- Suicide - Crime - Traffic accidents - Unemployment	- Life expectancy - National income - Forest area - Water service
Golany, Thore (1997)	72 Countries	- 15 year of domestic investment - 15 year of gov. consumption - 15 year of gov. exp. education	- Growth rate - 1 - Infant mortality - Enr. secondary education - Welfare payments
Zhu (2001)	20 Cities (15 USA, 5 international)	- High-end housing price - Lower-end housing rental - Cost of French bread - Cost of martini - Class A office rental - Violent crimes	- Household income - Population with degree - Doctors - Museums - Libraries - Golf courses
Mahlberg, Obersteiner, (2001)	174 Countries	- Uniform	- Life expectancy - Adult literacy rate - Combined enr. ratio - Adj. income
Zaim et al. (2001)	55 Countries	- Capital stock - Labor	- Infant survival rate - Life expectancy - Enr. primary school - Enr. secondary school - GDP
Murias et al (2006)	50 Spanish provinces	- Gini index - Pop. minimum incomes - Unemployment	- Disposable income - Size of dwelling - Net capital - Human capital - Long-term contracts
Ramanhatan (2006)	18 MENA Countries	- Age dependency ratio - Illiteracy rate, adult female - Mortality rate, infant	- Employment - Life expectancy - Primary education -GNP
Mizobuchi (2014)	OECD Countries	- Produced capital - Natural capital - Intangible capital	- BLI

3. The Model

The aim of this paper is twofold. Our first objective is to propose an aggregation method of the Better Life Variables (OECD, 2013); the second is to evaluate how different countries are comparatively efficient in obtaining welfare and well-being[12]. To this aim, we have to define a production function whose output is BL.

OUTPUT

OECD calculates the Better Life Index for all the 34 member countries (and for Brasil and Russia). The Index has 11 dimensions: *Housing*, *Income*, *Jobs*, *Community*, *Education*, *Environment*, *Civic engagement*, *Health*, *Life Satisfaction*, *Safety*, *Work-Life Balance*. Each of the eleven dimensions is made of two or more variables, so that the total number of variables necessary to get the BLI is 24: 16 variables have positive sign (BLI gets higher as they increase: e.g. *life expectancy*), 8 variables have negative sign (as it is for *Dwellings without basic facilities* or *Housing expenditure*). Table 2 below shows the variables related to the 11 dimensions of BLI.

TAB. 2: *Dimensions and related variables of the BLI*

Dimensions	**Related variables**
Housing	Dwellings without basic facilities Housing expenditure Rooms per person
Income	Household net adjusted disposable income Household net financial wealth
Jobs	Employment rate Job security Long-term unemployment rate Personal earnings
Community	Quality of support network
Education	Educational attainment Student skills Years in education
Environment	Air pollution Water quality
Civic engagement	Consultation on rule-making Voter turnout
Health	Life expectancy Self-reported health
Life Satisfaction	Life satisfaction
Safety	Assault rate Homicide rate
Work-Life Balance	Employees working very long hours Time devoted to leisure and personal care

OECD normalizes the 11 dimensions of the Better Life Index by rescaling them from 0 to 10. Three steps are necessary to restrict 24 variables into 11 dimensions. The first is a normalization (*min max method* OECD, 2008 p. 30):

$$index = \left(\frac{observed\ value - minimum\ value}{maximum\ value - minimum\ value}\right) \times 10 \quad (1)$$

The second step is a translation applied to negative variables (*bad outputs*):

$$(1 - index) \quad (2)$$

The third aggregates:

[12] Different aggregations of Better Life Index have already been proposed by Mizobuchi (2014) and Marković et al. (2015)

$$index = \left(\frac{\sum_{i=1}^{N} x\ i}{N} \right) \quad (3)$$

We proceed by observing that the use of Data Development Analysis to estimate the efficiency in the production of BL requires the use of original variables. This is true for at least two good reasons. First, many DEA methods are not *translation-invariant*[13] and (1) and (2) are translations. Second, (3) implicitly assigns equal weight to different variables, while one of the most valuable properties of DEA is independency from pre-assigned weight given to the inputs of the production function. Accordingly, we avoid using the 11 dimensions of BLI as outputs (as it is in the work by Mizobuchi 2014), and we use original variables as 16 positive outputs and 8 negative ones.

INPUT

Each country obtains welfare and well-being outcomes by using its available resources (Arrow *et al.*, 2004). Most recent works use, as input, labor and physical capital (Zaim *et al*, 2011), or the variable *wealth of nations* (Mizobuchi, 2014), which is the sum of natural, human and physical capital calculated by the World Bank.

In order to get undistorted outcomes, in our opinion, an efficiency analysis strictly requires a distinction between available capital and capital actually used.[14] To clarify this choice, imagine a country with a very large land extension and the same population as in another smaller country. The first country will have more fixed capital even if using the same quantity of the second (think the necessary infrastructures, roads, and so on). If we included the entire available capital as input, the first country would automatically result less efficient than the second one. Moreover, we would get results inconsistent with the sustainability criteria (Arrow *et al.*, 2004)[15] and potentially perverse policy hints: using immediately the whole amount of resources would lead to better results.

Taking into account these considerations, and unlike Zaim *et al* (2011) e Mizobuchi (2014), we include the *use of* human and physical capital (*consumption of fixed capital* e *hours worked*)[16] as inputs.

METHOD

Using *Better Life Index* data in a DEA model poses two kind of problems. On the one hand the large number of variables contained in the Index greatly limits the selective power of DEA . There are 24 outputs and 2 inputs variables with 35 observations (Countries) yielding a variables to cases ratio well above the conventional standard (Dison et al. 2001) and exposing the analysis to the "dimensionality curse" of DEA . On the other hand some of the variables have the nature of "bad" outputs (8 out of 24 output variables) and they pose a difficult problem to any DEA model because there is no fully satisfactory method, so far available, to deal with such type of variables.

In order to overcome the dimensionality problem we follow the idea, first put forward by Ueda and Hoshiai (1997), Adler, Golany (2001, 2007) e Adler, Yazhemsky (2010) of integrating Principal Component Analysis (PCA) into DEA models. PCA makes it possible to reduce the number of variables while retaining large part of data variability (70-80% is the commonly accepted threshold). Because early procedures, suggested for integrating principal components into DEA, face the problem of negative data brought about by the possibility of negative loadings which can result from the single value decomposition of the correlation matrix of the data, we follow the procedure proposed by Yap et al. (2013) in selecting only positive loadings. The resulting principal variables are necessarily positive and still represent the recommended (70-80%) of the original data variability. By following this procedure in loading selection the original 16 "good" output variables get reduced to 5 latent variables containing 73% of the original data variability. Likewise, the

[13] Pastor (1996) shows that in the cases where we have a translated output, it is only safe the use of the old version of BCC input oriented or of the additive VRS.
[14] Obviously, causal relations are somehow circular - health is at the same time an output and an input for the quality of life - but the objective is to find the most original determinants.
[15] This would be an acceptable approximation only in the case of missing indicators, with the presumption that having more resources implies consuming more of them.
[16] OECD (2015a), World Bank (2015).

original 8 "bad" outputs variables are reduced to 4 latent variables with 78% of explained variance. On the input side, as there are only 2 variables (capital and labour) we decided not to use principal variables.[17]

To deal with the problem posed by the presence of "bad" outputs and taking into account that in DEA literature on "bad" output there is not a procedure which dominates the others, we propose to rely on two alternative models. One proposed by Tone, Tsutsui (2006) based on the idea that "bad" outputs are better seen as inputs and are part of a single production system, which includes bad and good outputs besides inputs. Therefore the model attaches a higher efficiency index to cases (DMU) where production of "good" outputs is carried out with relatively less use (production) of inputs (bad outputs). The model is Slack based Measure (SBM), capable therefore to isolate both the traditional, radial, component of inefficiency, and its mix component[18].

The linear program of the modified Tone, Tsutsui (2006) model is:

$$\begin{gathered}\min_{t,\boldsymbol{z},\boldsymbol{s_G},\boldsymbol{s_B},\boldsymbol{\lambda}} \tau = t - \boldsymbol{p_X^T z}\\ t + \boldsymbol{p_{Y_G}^T s_G} + \boldsymbol{p_{Y_B}^T s_B} = 1\\ tL_{Y_G}\boldsymbol{y_{GR}} = L_{Y_G}Y_G\boldsymbol{\lambda} - \boldsymbol{s_G}\\ tL_{Y_B}\boldsymbol{y_{BR}} = L_{Y_B}Y_B\boldsymbol{\lambda} + \boldsymbol{s_B}\\ tL_X\boldsymbol{x_R} = L_XX\boldsymbol{\lambda} + \boldsymbol{z}\\ t,\boldsymbol{z},\boldsymbol{s_G},\boldsymbol{s_B},\boldsymbol{\lambda} \geq 0\end{gathered} \quad (4)$$

Where X is the m by n matrix of m input and n Countries, Y_G is the k by n matrix of k good outputs, Y_B is the j by n matrix of j bad outputs; t is a scalar, $\mathbf{z}$, $\boldsymbol{s_G}$ and $\boldsymbol{s_B}$, are, respectively, (m×1), (k×1) and (j×1) column vectors of input, god output and bad output slacks; $\boldsymbol{p_X^T}$, $\boldsymbol{p_{Y_G}^T}$ and $\boldsymbol{p_{Y_B}^T}$ are row vectors of input, good output and bad output weights. In addition to the symbols of Tone, Tsutsui (2006), we have introduced matrices L_{Y_G}, L_{Y_B} and L_X made of (row) eigenvectors obtained from single value decomposition of X and Y_G and Y_B correlation matrix, respectively, after modification proposed by Yap et al. (2013).

One shortcoming of this model is that it fails to distinguish between sources of inefficiency. There is no way to attribute inefficiency to the production of "good" output or "bad" output. It can happen that a DMU is overall efficient because it performs well in producing good outputs while doing poorly for "bad" outputs, or the other way round. In cases where "bad" outputs are an important part of the problem, this feature of the model limits its information contents.

To overcome this problem it has been proposed (Luptacik, 2000) to split the analysis into three steps. On the first one, the efficiency index of producing good outputs with conventional inputs is evaluated Technical Efficiency. Then as a second step, one computes the efficiency index of producing good outputs out of "bad" outputs (treated as inputs). We call it Social Efficiency. The last step proceeds to summarise these two indices of efficiency into a single one by a standard DEA model, which takes the two indices of efficiency as outputs while a uniform input (usually set to unit value) is imputed to all the DMUs. The model of Luptacick (2000) here is reproduced in the SBM version, the linear program used in the three steps proposed by Luptacik (2000) is:

$$\begin{gathered}\min_{t,\boldsymbol{\lambda},\boldsymbol{s},\boldsymbol{z}} \tau = t - \boldsymbol{p_X^T z}\\ t + \boldsymbol{p_Y^T s} = 1\\ tL_Y\boldsymbol{y_R} - L_YY\boldsymbol{\lambda} + \boldsymbol{s} = 0\\ tL_X\boldsymbol{x_R} - L_XX\boldsymbol{\lambda} - \boldsymbol{z} = 0\\ t,\boldsymbol{\lambda},\boldsymbol{s},\boldsymbol{z} \geq 0\end{gathered} \quad (5)$$

Where X is the m by n matrix of m inputs, that in the first step are once capital and labor and once the bad outputs, in the second step is an horizontal vector of n equal scalars (one for each Country); Y is the s by n matrix of s outputs that in the first step are the good outputs and in the second step are the score obtained in the first two steps; $\boldsymbol{z}$ and $\boldsymbol{s}$ are, respectively, (m×1) and (s×1) column vectors of input and output slacks; $\boldsymbol{p_X^T}$ and $\boldsymbol{p_Y^T}$ are row vectors of input and output weights. L_Y and L_X are the (row) eigenvectors obtained from

[17] We did actually run PCA on the two input variables. However the eigenvectors showed loadings of similar size with opposing signs, suggesting that the original variables tend to be orthogonal (higher capital input correspond to lower labour input). In this case, limiting the choice to only one latent variable would heavily reduce explained variation.

[18] Mix inefficiency measures the inefficiency due to the "wrong" combination of inputs and outputs.

single value decomposition of X and Y correlation matrix, respectively, after modification proposed by Yap et al. (2013).

4. Data description

We have 35 Decision Making Units (all the OECD members and Russia[19]); the 24 outputs (taken from the OECD, 2013), 2015 edition, are listed in Tab. 3 below.

TAB. 3: *Output Summary*

Good Output	**Ref. year**	**Average**	**St. Dev.**	**Max**	**Min**
Rooms per person	2013	1,662857	0,438638	2,5	0,9
Household net adjusted disposable income	2012	24477,66	7054,113	41355	13085
Household net financial wealth	2012	41228,03	32402,94	145769	3251
Employment rate	2013	66,37143	7,700595	82	49
Personal earnings	2013	36593,17	12830,45	56340	16193
Quality of support network	2014	89,62857	5,173949	96	72
Educational attainment	2012	76,22857	15,96335	94	34
Student skills	2012	496,6857	26,33581	542	417
Years in education	2012	17,52571	1,296906	19,8	14,4
Water quality	2014	83	10,59967	97	56
Consultation on rule-making	2008	7,157143	2,662626	11,5	2
Voter turnout	2010-15	69,91429	12,25554	93	49
Life expectancy	2012	79,90857	2,926187	83,2	70,2
Self-reported health	2013	67,88571	14,59003	90	30
Life satisfaction	2014	6,571429	0,797264	7,5	4,8
Time devoted to leisure and personal care	1999-11	14,87886	0,549201	16,06	13,42
Bad Output	**Ref. year**	**Average**	**St. Dev.**	**Max**	**Min**
Dwellings without basic facilities	2013	2,414286	3,73569	15,1	0
Housing expenditure	2012	20,82857	2,884907	26	11
Job security	2013	5,702857	2,799105	17,8	2,4
Long-term unemployment rate	2013	3,579429	3,936068	18,39	0,01
Air pollution	2010	19,94286	8,3135	46	9
Assault rate	2010	3,94	2,169061	12,8	1,3
Homicide rate	2012	2,182857	4,347784	23,4	0,3
Employees working very long hours	2013	9,12	8,457605	40,86	0,16

Source: OECD (2013), 2015 edition

As anticipated in the model description, we choose: *Consumption of fixed capital* (World Bank, 2013) and *Hours worked* (OECD, 2015a), as input variables; the reference year for both variables is 2012, because most of the outputs refers to 2012/2013 (Tab. 3). In order to get a scale-independent analysis (Par. 3), we use per-capita values for both inputs. Tab. 4 shows the values used for the two inputs.

Tab. 4: *Input summary (Per capita data)*

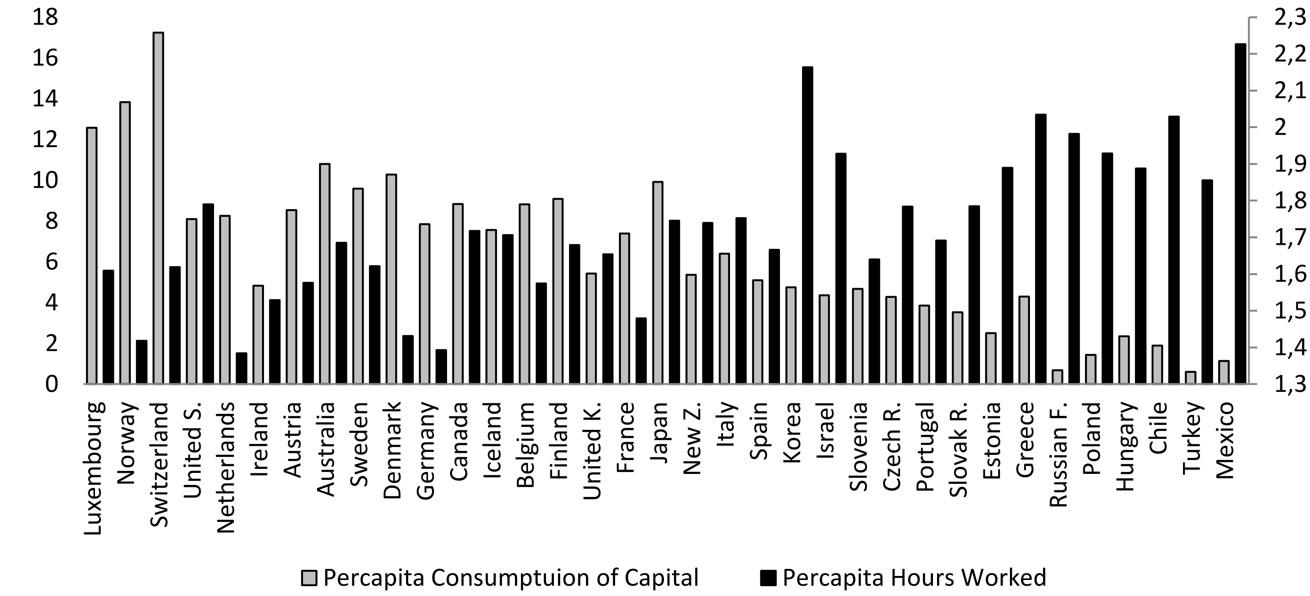
Input	**Ref. year**	**Average**	**St. Dev.**	**Max**	**Min**
Average hours worked	2012	1731,114	207,8588	2226	1384
Consumptuion of fixed capital	2012	6457,686	3880,714	17239,72	607,8344

Source: OECD (2015a), World Bank (2015)

[19] BLI is available for 36 countries. As Brasil lacks data on labor, we exclude it from our analysis.

Fig. 1 shows levels of (per capita) capital and work across countries, ordered by GDP (per capita). It can be easily noted that the richest country (Luxemburg) has one of the highest consumption af capital while the poorest (Mexico) has one of the lowest. In the middle, the use of capital decrease with per capita GDP. The use of work follows a different path: though it is not strictly increasing with GDP, poorer countries use more work than the richer (in line with development theories see, for example, Kravis amd Lipsey, 1983)

FIG. 1: Consumption of labor and capital in OECD countries



Note: on the left vertical axis there is capital in (per capita) thousands of dollars, on the right hand axis there are (per capita) thousands of hours worked in one year.
Source: OECD (2015a,b), World Bank (2015)

5. Results

Let us first look at how efficiently GDP is produced. To this aim, we evaluate countries on the produced per capita GDP by the means of a mix of consumption of capital and hours worked (see Par. Model). Fig. 2 clearly shows that technical efficiency does not imply a high GDP: Russia, Ireland and Luxemburg are on the frontier, (they are efficient), though they have very different GDP. Countries most distant from the frontier belong to very different classes of income: Japan and Switzerland are inefficient as they are Greece and Mexico, much poorer than the former. Differences among rich and poor countries remain: the former use too much capital (north-west of Fig. 2), the latter too much work (south-est of Fig. 2).

5.1 Global efficiency producing Better Life

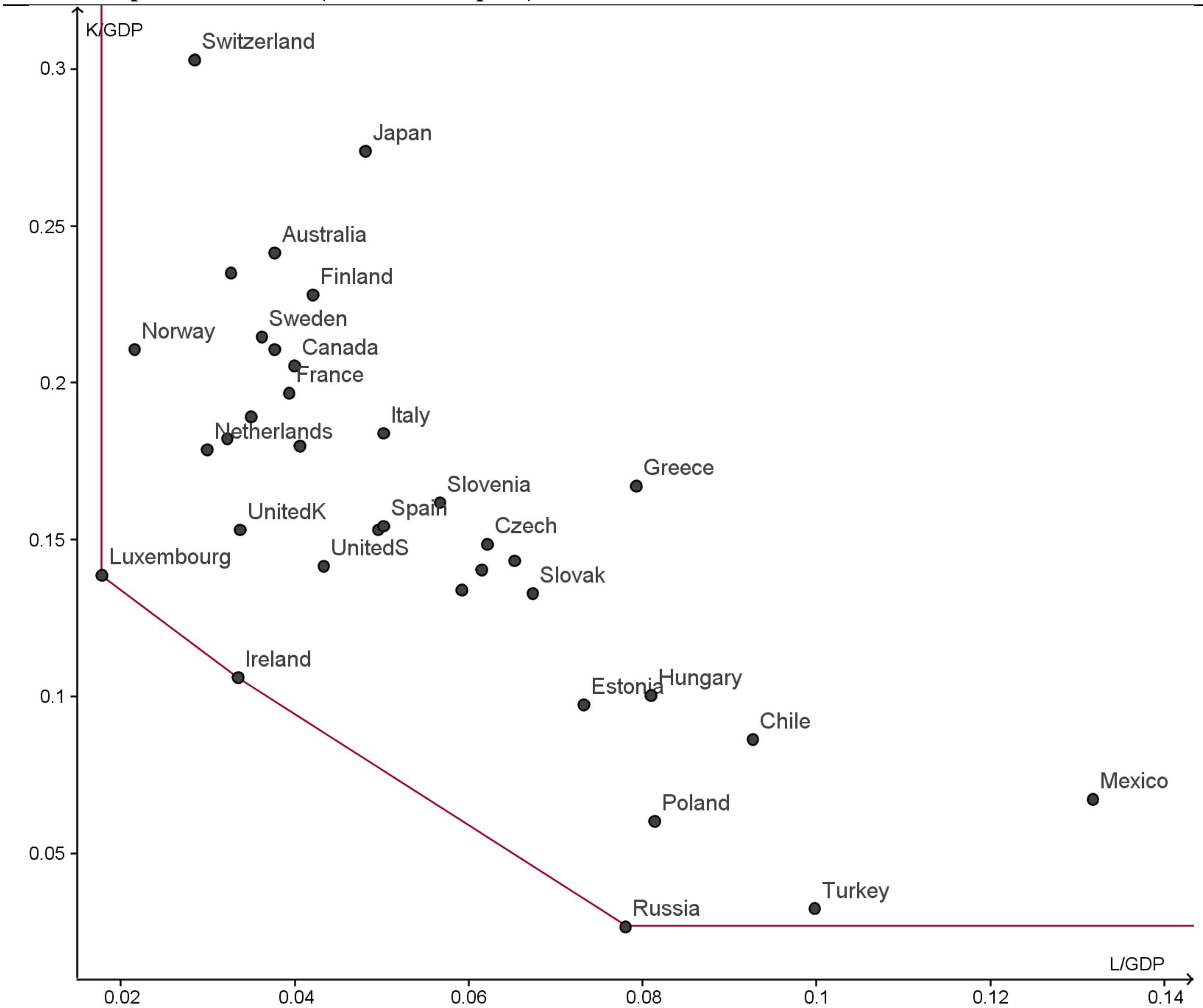
We are now ready to proceed with the evaluation of the relative efficiency of different countries in producing BLI, using program (4) of DEA. We consider the production process that uses two inputs (per capita hours worked and per capita consumption of capital) in producing one output. This way we get a measure of how efficiently BLI is "produced" by DEA, the Efficient Better Life (hereafter EBL), to be compared with Aggregate Better Life (hereafter ABL), which is calculated with constant input for each country.

Fig. 3 shows a comparison between GDP (black dot), ABL (white square), and EBL (white rhombus) . The values of GDP are normalized to the GDP of Luxemburg, which is the highest).

Two kinds of observations are in order. A) the comparison between GDP and ABL; B) the comparison between ABL and EBL.

A) GDP is generally positively correlated with ABL but this is true up to a certain level of GDP. In fact, higher income countries have the same ABL (Austria and Netherlands have a lower ABL than countries with similar or lower GDP). In other words, marginal productivity of GDP on ABL is somehow decreasing, and it gets to zero as GDP gets to the level of low-middle income countries.

FIG. 2: Inputs/ GDP ratios (Labor and capital)



Original data source: OECD (2015a,b), World Bank (2015)

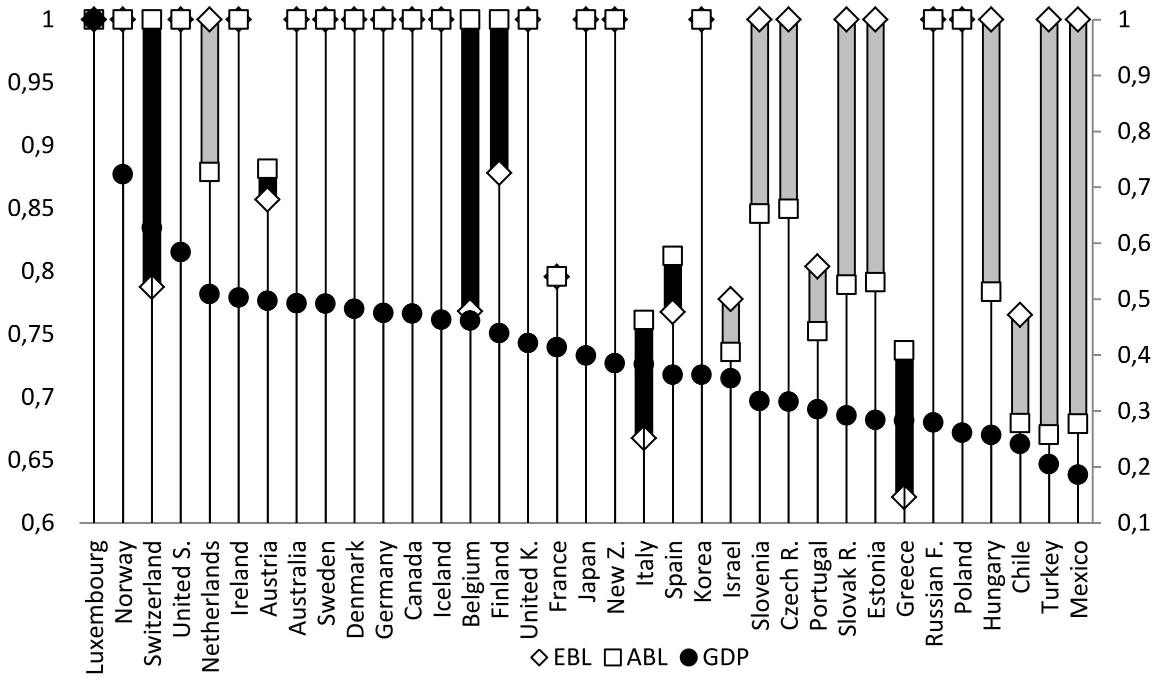
This is a result in line with others according to which quality of life is only partially related to GDP. For example, from the research work of late 80s (Fuà, 1993), we know that life expectancy at birth, increases at a decreasing rate with respect to GDP per capita. The same is true in the happiness literature, which proves that economic prosperity, measured by GDP per head, is not necessarily associated with greater happiness (Easterlin, 1974).

The evidence that GDP is not a good predictor of quality of life, has led institutions to the attempt of quantifying several aspects of well-being and incorporate them into enhanced indicators of progress, like BLI. Fig. 3 is in line with the happiness paradox.

B) Results in terms of ABL differ from EBL, namely countries perform differently when the use of inputs to produce BL is taken into account. Fig. 3 shows this comparison. Grey bar signal a gain in relative efficiency when inputs are considered, Black lines indicate a loss in efficiency. On average, poorer countries show an efficiency gain (with the exception of Greece), richer a loss (Netherlands is the only exception).

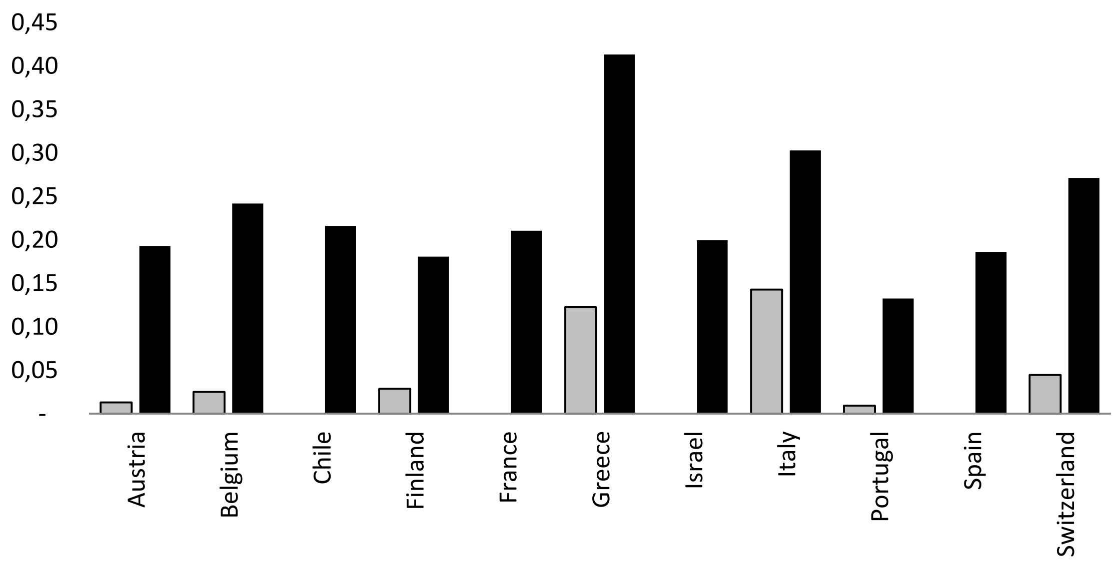
Our model yields also a variety of *slacks*, a measure of the inefficiency in each single well-being dimension (in our model it is measured by the distance from the efficiency frontier). Fig. 4, Tab. 5 and Tab. 6 should be useful to a get a straightforward interpretation of the slacks. Take Greece, for example: Fig. 4 shows that Greece could achieve the same BLI achieved, by lowering the consumption of capital by 41% and the hours worked by 12%. Tab. 5 tells us which output dimensions could be improved by using the “efficient” amount of input: the number 0,77 means that Educational attainment could be improved by 77%, 48% Consultation on rule-making by 48%, and so on. Tab. 6 summarizes the results of program (4) in inefficient countries. The productive unities (countries) on the frontier, i.e. reference unities for inefficient countries (Peer countries) are shown from the fourth column onward. For example, Greece's peers are Poland, Ireland and Hungary.[20] The second column of Tab. 6 reports the score of efficiency: 0,62, e.g., means that Greece is on average 62% as efficient as its peers. The third column of Tab. 6 reports the Returns to Scale of the inefficient countries: IRS means that the scale of production should be increased for the country to get efficient, DRS means that the (inefficient) country should decrease the scale of production (Switzerland and Finland).

FIG. 3: GDP, Aggregate Better Life, and Efficient Better Life



Note: GDP is normalized to the maximum value of GDP (Luxemburg), ABL is aggregated by DEA program (4) with the same inputs for all countries.
Source: OECD (2013, 2015b)

FIG. 4: Input Slacks



[20] Slacks are indeed computed over a linear combination of input and outputs of the peer countries, as if we got an ideal country to be compared with each inefficient unit.

TAB. 5: *Output Slacks*

Output	Austria	Belg.	Chile	Finl.	France	Greece	Israel	Italy	Port.	Spain	Switz.
Rooms	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,09	0,00
Income	0,00	0,00	0,00	0,05	0,00	0,00	0,06	0,00	0,00	0,00	0,00
Wealth	0,00	0,00	0,00	3,77	0,00	0,00	0,14	0,00	0,00	1,02	0,00
Employment	0,00	0,00	0,00	0,02	0,00	0,00	0,00	0,00	0,00	0,13	0,00
Earnings	0,00	0,00	0,00	0,29	0,00	0,00	0,00	0,00	0,00	0,12	0,00
Network	0,03	0,02	0,04	0,00	0,05	0,00	0,00	0,00	0,01	0,00	0,12
Ed. Attainment	0,00	0,55	1,64	0,02	0,19	0,77	0,25	0,44	1,32	0,90	0,21
Student Skills	0,00	0,00	0,00	0,00	0,00	0,00	0,07	0,00	0,00	0,00	0,00
Years in Ed.	0,00	0,03	0,13	0,00	0,06	0,00	0,22	0,00	0,01	0,00	0,00
Water Q.	0,00	0,00	0,00	0,00	0,00	0,00	0,05	0,00	0,00	0,00	0,00
Consultation	0,00	0,58	1,54	0,00	1,21	0,48	2,11	0,85	0,44	0,38	0,00
Voter	0,03	0,02	0,07	0,15	0,08	0,11	0,00	0,10	0,37	0,08	0,36
Life Exp.	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00
Self-rep. Health	0,00	0,03	0,05	0,00	0,07	0,08	0,00	0,11	0,41	0,07	0,00
Life Satisf.	0,01	0,02	0,02	0,07	0,02	0,07	0,00	0,06	0,20	0,04	0,11
Personal Care	0,05	0,02	0,07	0,00	0,03	0,00	0,11	0,00	0,00	0,00	0,14
Facilities	5,75	2,07	0,79	0,00	0,72	0,00	0,53	1,83	0,00	7,50	0,00
Housing Exp.	0,00	0,00	0,16	0,04	0,07	0,20	0,10	0,23	0,00	0,09	0,09
Job Sec.	0,00	0,00	0,00	0,00	0,00	0,63	0,00	0,00	0,50	0,43	0,00
Unemployment	0,00	0,00	0,00	0,00	0,00	0,58	0,00	0,00	0,00	0,84	0,00
Air Pollution	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,07	0,00
Assault	0,00	0,00	0,00	0,00	0,00	0,25	0,00	0,00	0,00	0,20	0,00
Homicide	0,02	6,36	0,38	0,00	6,75	1,11	1,32	6,23	6,44	2,70	2,05
Long Work	0,00	0,00	1,22	0,00	0,19	0,00	0,26	1,01	0,00	0,28	0,39

TAB. 6: *Relative Performance of the Inefficient Countries*

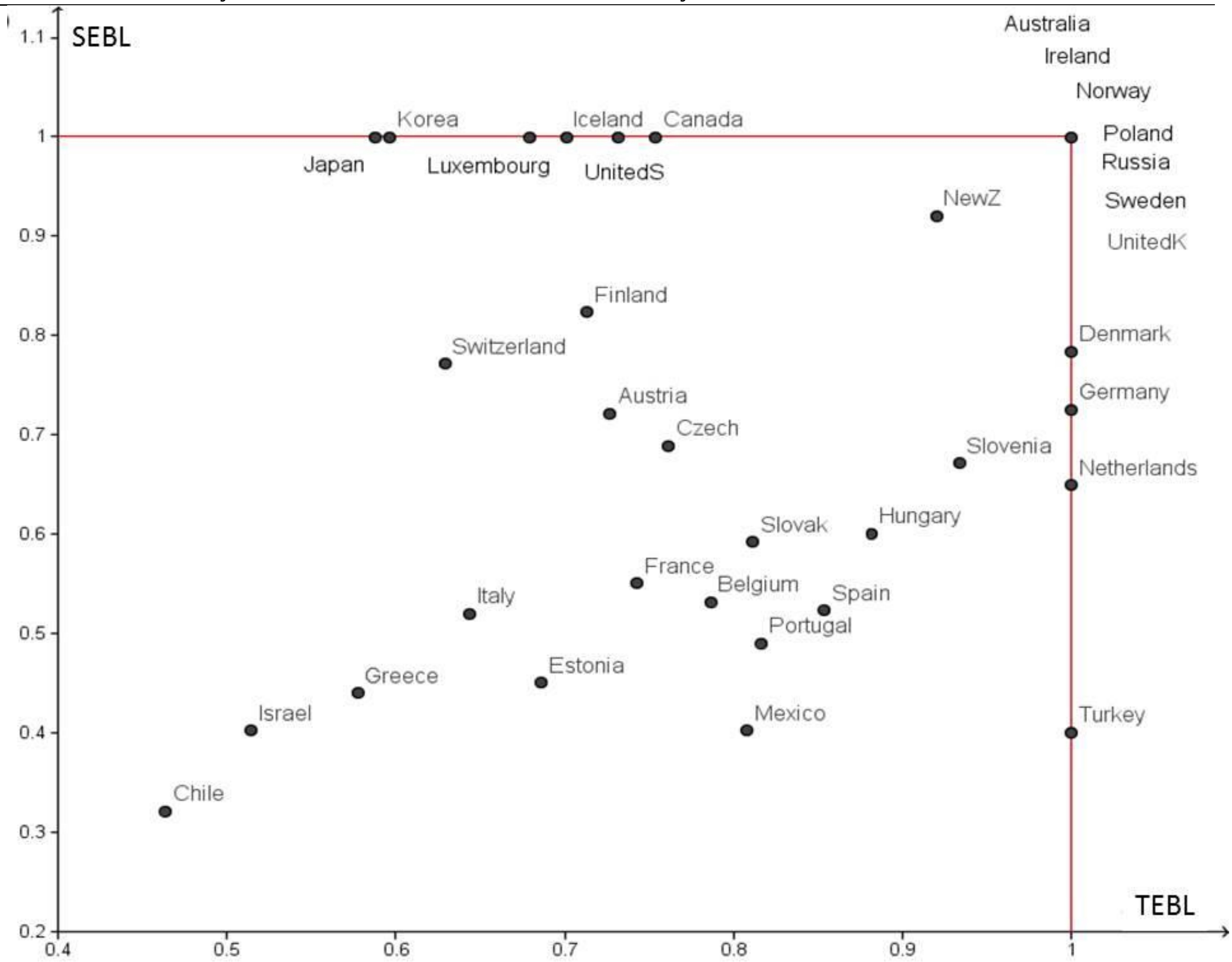
Country	score	Scale	peer 1	peer 2	peer 3	peer 4	peer 5
Greece	0,62	IRS	Poland	Ireland	Hungary		
Italy	0,67	IRS	Ireland	Poland	New Z.		
Chile	0,76	IRS	Russian F.	Poland	United K.		
Spain	0,77	IRS	Ireland	Poland			
Belgium	0,77	IRS	Germany	Ireland	New Z.		
Israel	0,77	IRS	New Z.	Russian F.	Poland		
Switzerland	0,79	DRS	Norway	Germany	New Z.		
France	0,79	IRS	Ireland	Germany	United K.		
Portugal	0,80	IRS	Ireland	Poland	Russian F.		
Austria	0,86	IRS	Germany	New Z.	United S.	Korea	Ireland
Finland	0,88	DRS	Canada	Ireland	Germany	New Z.	Sweden

5.2 Social and Technical Efficiency

The model of Luptacick (2000), as reported in Par.4, here reproduced in SBM version with the program (5), allows to split efficiency into two components: Social and Technical in the production of Better Life (respectively, SEBL and TEBL). Social efficiency regards the social costs of a Better Life[21], namely the amount of bad outputs produced to get the set of good outputs. Technical efficiency relates to the amount of conventional inputs used (capital and labor) to get the set of good outputs.

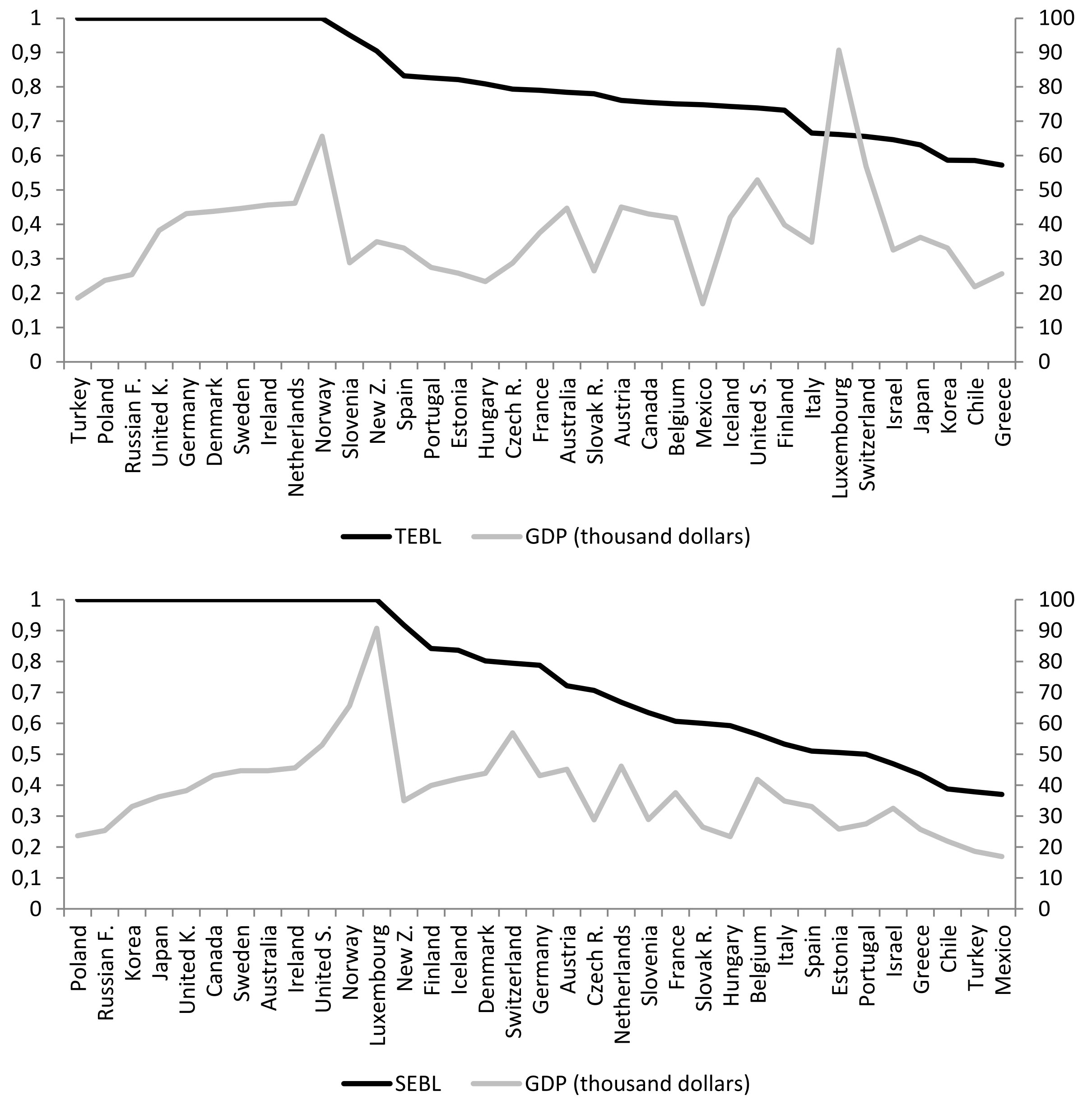
Fig. 5 has SEBL on the vertical axis and TEBL on the horizontal. It shows the position of countries in terms of the mix of technical and social efficiency. Some of them are only efficient on the technical side (like Denmark and Germany), others are only socially efficient (as Canada and United States), and seven of them are efficient under both criteria. Inside the frontier, there are the countries not efficient in any dimension.

FIG. 5: Countries by the mix of Technical and Social Efficiency



[21] The *bad* outputs in Tab. 3, the undesirable effects of economic activity

FIG. 6: Technical Efficiency and GDP, Social Efficiency and GDP

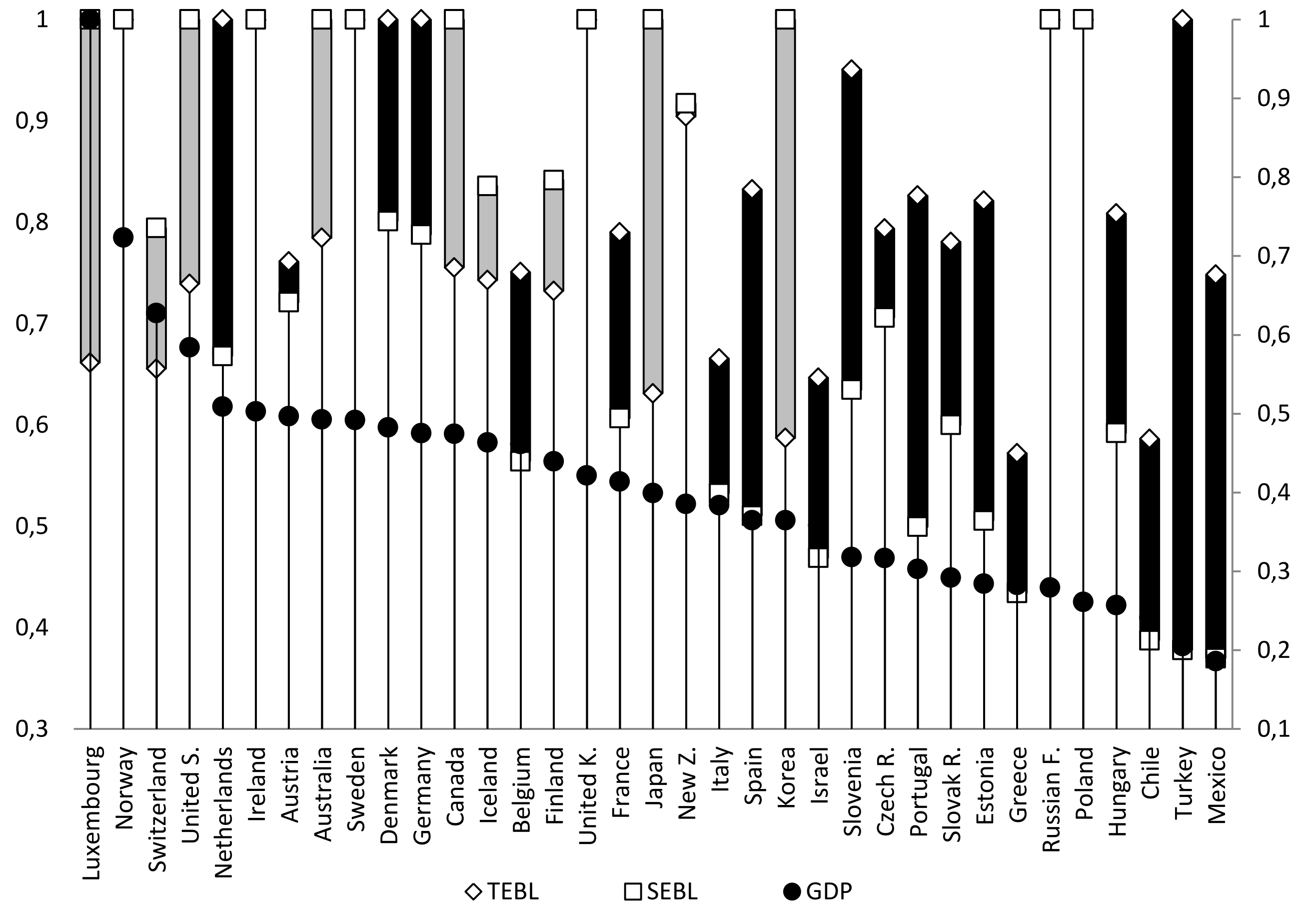


These findings are in line with the interpretation of per capita GDP as an indicator of development (World Economic Forum, 2013), but this analysis qualifies it. At earlier stages of economic development, countries are somehow more interested in technical efficiency, while more developed countries are ready to spend some technical efficiency to get social efficiency (Fig. 7). In other words, we observe a different use of resources as the social cost of welfare gains importance. Getting a Better Life, namely an increase in the overall quality of life, may be costly in terms of conventional inputs. Thus, the choice of spending part of conventional inputs to reduce bad outputs may cause a relative decline of good outputs and consequently a loss in technical efficiency, but not in GDP.

Social efficiency is the only index that clearly distinguishes rich and poor countries. Thus, it could be itself the ingredient of material wellness. A causal direction is plausible in the two directions: either a higher GDP creates the conditions for saving natural and social resources, or higher social capital creates itself a positive background for the GDP to increase. Further research on this is necessary and worthwhile.

By comparing social and technical efficiency (Fig. 8), we observe that almost all poorer countries have higher technical than social efficiency. This is not true for higher GDP countries. For example Netherlands, Austria as well as Germany and Canada have higher Technical than Social efficiency, while Luxemburg Switzerland Australia and Canada have better social than technical efficiency.

FIG. 8: Technical Efficiency, Social Efficiency and GDP



Note: Technical efficiency (white rhombus), Social efficiency (white square), GDP (black dot). Countries are ordered by per capita income (decreasing from left to right). The gray (black) bar indicates that Social Efficiency is higher (lower) than technical efficiency.
Source: OECD (2015b)

5.3 Results at a glance

Correlations among the results of our analysis are reported in Tab.6. Remember that ABL (Aggregated Better Life) is the BLI aggregated by program (4) with no input considered; Eff_ GDP is program (4) applied to GDP as the output obtained by the use of conventional inputs (per capita capital and hours worked); EBL is BL aggregated by program (4) with standard inputs (capital and labor). TEBL is technical efficiency and SEBL is social efficiency in the production of Better life. TSEBL is the aggregation of TEBL and SEBL by program (5) as in Luptacik (2000).

Summarizing the results, Tab. 6 shows a high correlation between GDP and ABL, confirming that part of the BLI is still related to the GDP. We have already seen (Par 5.1) that the positive relation is evident only at low levels of income.

It can also be noted that there is a high correlation between GDP and SEBL, confirming a less eco-social impact in the production of well-being by rich countries.

The highest correlation, is between ABL and SEBL. This is due to the similarities of the indices. In fact, the only difference is that ABL has a constant input for all countries, while this is not the case for SEBL. This is the reason why efficiency in ABL signal the capability of a Country, to perform better than the others, at least in one dimension.

High correlation between SEBL and TSEBL means that the aggregation suggested by Luptacik (2000) in our case assigns high weight to SEBL.

The last correlation (SEBL and TSEBL), coupled with the high correlation between ABL and SEBL, makes the correlation between ABL and TSEBL high. This result could challenge the relation between ABL and EBL.

In other words, TSEBL (the aggregation proposed by Luptacik, 2000) here assigns more weight to SEBL, SEBL is strictly connected to ABL and this is what makes the correlation between ABL and TSEBL high.

The only case of negative correlation (although not significant), is between TEBL and GDP: it signals that high efficiency and high income cannot be considered a proxy to each other.

TAB. 6: *Correlation (95% confidence interval)*

	GDP	**ABL**	**Eff_ GDP**	**EBL**	**TEBL**	**SEBL**	**TSEBL**
GDP	1,000						
Lower bound	0,336						
ABL	0,602	1,000					
Upper bound	0,779						
Lower bound	-0,028	-0,160					
Eff_ GDP	0,309	0,183	1,000				
Upper bound	0,582	0,487					
Lower bound	-0,215	0,128	-0,020				
EBL	0,127	0,443	0,316	1,000			
Upper bound	0,442	0,676	0,587				
Lower bound	-0,349	-0,085	0,118	0,243			
TEBL	-0,018	0,255	0,434	0,533	1,000		
Upper bound	0,318	0,542	0,670	0,736			
Lower bound	0,272	0,836	-0,046	0,277	-0,082		
SEBL	0,555	0,914	0,292	0,559	0,259	1,000	
Upper bound	0,750	0,956	0,570	0,752	0,545		
Lower bound	0,115	0,705	0,076	0,354	0,386	0,800	
TSEBL	0,432	0,841	0,399	0,615	0,637	0,895	1,000
Upper bound	0,669	0,917	0,646	0,787	0,800	0,946	

Concluding remarks

The OECD launched the Better Life Index in 2011. The multidimensional index was meant to overcome the poorness of the GDP as an indicator of welfare and, to this aim, it measures economic and social progress by combining objective and subjective indicators of welfare and well-being. Yet, the Better Life Index, as well as other multidimensional indexes developed before it, is still not a real candidate to substitute the use of GDP in international comparisons and accounting. One of the reasons why it happens is that a multidimensional index is quite difficult to handle, at least as far as international comparisons are concerned. Any information about the global relative performance of countries should rely on a given system of weights assigned to variables, which would make it somehow less acceptable.

In this paper, we have suggested a method of aggregation of the Better Life Index by combining Principal Components Analysis and Data Development Analysis, which allows for a prior-free aggregation of variables. Our results show that the aggregated Better Life Index is correlated to the GDP only for low GDP countries. This is in line with the results according to which there is threshold after which economic gains no longer correlate with increases in well-being (Veenhoven, 2008; Costanza et al. 2009)

In order to evaluate the relative efficiency of different countries in the production of quality of life, we have then gone through two different methods. The first method follows the approach of Tone et al. (2006). We have chosen two conventional inputs, work and capital, as the inputs of the production function generating welfare and well-being in the form they take in the Better Life Index. Our results show clearly that a country with a good GDP does not necessarily produce it efficiently. In a way, this result strengthens the Happiness Paradox, pioneered by Richard Easterlin, and it extends the result to the quality of life. In addition, when we compare the aggregated Better Life Index with the measure of efficiency applied to it (i.e. when we consider the inputs used to produce all the variables of Better Life), we find that poorer countries are generally more efficient than richer ones.

The second method follows Luptacik (2000). By this method, we split the analysis into three steps. On the first one, we evaluate the efficiency index of producing good outputs with conventional inputs. Then as a second step, we compute the efficiency index of producing good outputs out of "bad" outputs (treated as inputs). The last step proceeds to summarise these two indices of efficiency into a single one by a standard DEA model, which takes the two indices of efficiency as outputs while a uniform input is imputed to all the DMUs. By comparing technical with social efficiency, we have seen that the former prevails on the latter when poorer countries are taken into account, while social efficiency is generally higher than technical efficiency in higher income countries. The model chosen makes it possible to observe that some countries succeed in getting both kinds of efficiency, showing that the two objectives can work in the same direction: pursuing the well-being of a population does not mean to undermine their material resources. As anticipated in the introduction, we can claim that desirable outcomes, even economic ones, go strictly together with the achievement of general well-being.

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