CHAPTER 2

The OECD Better Life Index: A Guide for Well-Being Based Economic Diplomacy

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1 INTRODUCTION

The recent global threats, such as climate change, financial crisis and pandemics, evidently manifest their direct impact on the well-being of people. At the same time, the international competition among the countries has sharpened to attract foreign investments, to gain access to foreign markets and to protect their domestic markets. However, these conflicting

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interests in conjunction with the economic interdependencies of markets and the fragmented political relationships have negative effect on the living conditions and the quality of life. Obviously, such a volatile environment renders imperative for the governments to interact and effectively cooperate to promote the international relations and reach economic and climate agreements. Addressing the world's challenges collectively through constructive diplomacy will enable governments to deliver better lives for their citizens. In this respect, it is of utmost importance to construct reliable well-being measures that can be employed as tools to support international economic diplomacy.

Well-being is multidimensional as it depends on a wide range of socio-economic aspects, such as material conditions, quality of life and sustainability. However, the multifaceted factors of well-being are of different importance and they may not follow the same trend. For instance, the economic growth is not always followed by other societal aspects, nor it is equally shared to all parts of societies. In addition, the quality of life is more important than income. Hence, to derive a better picture of how society performs in all areas, it is crucial to depart from the ordinary income-based measures (e.g., gross domestic product-GDP), which are inadequate to capture the societal progress, and shift the awareness to more comprehensive measures that incorporate multifaceted human-centric criteria.

On this basis, the Organization for Economic Co-operation and Development (OECD) launched the OECD Better Life initiative (Durand, 2015; OECD, 2011) with the aim to develop better well-being metrics, to facilitate the better understanding of what drives well-being of people and guide the policy-making. The initiative provides regular monitoring and benchmarking through the "*How's Life?*" reports (OECD, 2011, 2013a, 2015, 2017, 2020) and the interactive web platform (oecdbe tterlifeindex.org) that promotes the OECD Better Life Index (BLI). The OECD BLI covers several socio-economic aspects by incorporating eleven key topics (factors) that the OECD has identified as essential to well-being in terms of material living conditions and quality of life. The BLI has a hierarchical structure with three levels. In a bottom-up representation, the first (bottom) level comprises of the indicators that form the eleven topics of the second level, which subsequently form the BLI at the third level. The web application is designed to disseminate the BLI as well as to prompt people to share their views about the topics that matter most to them. The public participation is critical considering the varying

needs and the unequal distribution of the well-being outcomes among different regions and groups of the population. Also, the public opinion allows to focus on true-life conditions, hence it should be considered when creating well-being measures and policies. The OECD, except measures about the well-being at country (international) level, provides measures for regional well-being via the OECD regional well-being web platform (oecdregionalwellbeing.org). Hence, the concept of BLI can be readily applied at national level, i.e., for regional assessments.

Obtaining a single measure of well-being by synthesizing the multi-faceted components of BLI is challenging. However, the OECD has not adopted, so far, an aggregation approach for the case of BLI. It is left to the citizens though to create the BLI based on their views. This is explicitly declared in the BLI's website: "*Your Better Life Index is designed to let you, the user, investigate how each of the 11 topics can contribute to well-being*". The OECD Handbook for the construction of composite indices (OECD, 2008) provides directives and methodological tools. Nevertheless, there is still a great debate about the aggregation techniques that should be adopted (Greco et al., 2019a). In the frame of BLI, it is arbitrary to consider that the eleven topics are of equal importance, i.e., that people believe that each topic has the same impact on their life. Assuming equal weights for the construction of composite indices has justifiably faced criticism since it implies equal worth and contribution of the included topics, see Nardo et al. (2005). An alternative to the equal or fixed weighting procedure is the *Benefit of the Doubt* (BoD) approach, which is based on Data Envelopment Analysis (DEA) (Cooper et al., 2011). The BoD approach (Cherchye et al., 2007; Melyn & Moesen, 1991), is a popular approach for constructing composite indices where the weights derive endogenously from the optimization process. The BoD approach estimates different weights for each unit under assessment in its most favorable way to reach the highest possible performance. Rogge (2018) explored various weighted average functions in a BoD framework for the construction of composite indices. Smirlis (2020) introduced a trichotomic segmentation approach as initial preference information to estimate the values of composite indices. The aggregation procedure employs the BoD approach with common weights for all the assessed countries. However, in the BoD approach compensability among the different components of the indices is assumed.

An increasing literature body is focused on the construction of non-compensatory composite indicators. Bouyssou (1986) introduced general

aggregation methods that allow for a mix of compensatory and non-compensatory components. The non-compensatory aggregation methods do not allow an unfavorable value in one topic to be compensated by a favorable value in another topic (Roy, 1996). Despite their desirable properties, the non-compensatory methods are not as popular as the enhanced compensatory methods, which are preferred due to their simplicity in implementation. For instance, a solution to overcome the hypothesis of compensation that retains the simplicity of the implementation is to adopt the geometric aggregation method (Van Puyenbroeck & Rogge, 2017). Fusco (2015) dealt with non-compensability by introducing a directional penalty in the BoD model according to the variability of each topic. Zanella et al. (2015) proposed a directional BoD model for the assessment of composite indicators and imposed weight restrictions on the virtual weights, which reflect the relative importance of the topics in percentage terms. Similarly, Rogge et al. (2017) imposed weight restrictions in a directional distance BoD model.

In this chapter, we present the BLI and we discuss its applications reported in the literature. As BLI is not provided directly as an index by the OECD we present a hierarchical (bottom-up) evaluation methodology developed by Koronakos et al. (2019) that is based on Multiple Objective Programming. Also, the real views of people about well-being, as recorded by the OECD BLI web platform, are incorporated into the assessment models in the form of weight restrictions. The rest of the chapter unfolds as follows. In Sect. 2 we present the hierarchical structure of the BLI and its role in international economic diplomacy. In Sect. 3, we discuss the different methods proposed in the literature and in Sect. 4 we apply the approach introduced by Koronakos et al. (2019) for the BLI assessment of 38 countries (35 OECD and 3 non-OECD economies) for the year 2017. Conclusions are drawn in Sect. 5.

2   The OECD Better Life Index

The OECD framework covers dimensions of well-being that are universal and relevant for all people across the world. These dimensions are represented by eleven topics that compose the OECD Better Life Index. Each one of the eleven topics (level 2) of BLI is composed of one to four indicators (level 1). The indicators, as noticed in OECD (2011, 2013b), have been chosen in accordance with theory, practice and consultation
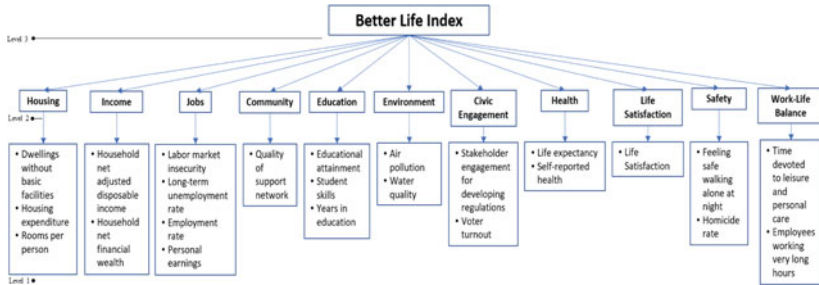
Fig. 1 The hierarchical structure of the OECD Better Life Index

with experts from various OECD directorates, about the issue of appropriate measuring of the well-being. The hierarchical three-level structure of Better Life Index is exhibited in Fig. 1. The indicators lie at the first (bottom) level, the topics are at the second level, and at the third level lies the resulting Better Life Index.

Among the eleven topics, the first three reflect material living conditions and the remaining eight are characterized as determinants of quality of life. A complete description of each topic and indicator included in the BLI can be found in the "*How's Life?*" report of OECD (2011) and the web platform.[1] The OECD provides for each indicator a clear picture about the specific aspects of well-being that it covers, its unit of measurement and the source of the data. The data mostly originate from official sources such as the OECD or National Accounts, United Nations Statistics and National Statistics Offices. The OECD BLI web platform presents the profiles and the performance in each indicator of the OECD countries and three key partners, namely Brazil, Russia and South Africa. Shortly, other countries will be included in OECD BLI such as China, India and Indonesia.

The BLI derives from the aggregation of the components that lie on three different levels. The indicators of level 1 are aggregated with equal weights to derive the values of each topic of level 2. This method, besides being employed by OECD for the BLI, it also prevails in the literature. On the other hand, the OECD has not proposed any specific weighting scheme for the aggregation of the eleven topics of level 2, whereas the

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[1] The OECD Better Life Index web platform https://www.oecdbetterlifeindex.

reported approaches in the literature are mainly devoted to this task. Up to now, OECD has focused on the dissemination of BLI and the recording of what matters most to the people about well-being. The BLI is not provided directly as an index by the OECD, also in the online platform is stated that "*the OECD has not assigned rankings to countries*". However, the aggregation scheme of the eleven topics for its construction is left to the people.

2.1   The Role of the OECD Better Life Index in International Economic Diplomacy

Economic Diplomacy, although driven by economic interests, indirectly is affected by the level of development of a country and by the well-being of its people. This link is mentioned in several research articles describing the exercise of Economic Diplomacy for different countries. Mudida (2012) focuses on aspects of the economic diplomacy of African countries, names it "diplomacy of development" and relates it with the quality of life of African citizens. Shichao (2012) ascertain that Singapore, although being a small country, achieved rapid growth, great improvements in its people's level of well-being and consequently developed Economic Diplomacy that in turn has put to reaching political and security goals.

The role of OECD is to assist governments to design and implement better policies for better well-being on a global scale. In the context of OECD 60th anniversary, the OECD Secretary-General Angel Gurría noticed "*Over the past 60 years, the OECD has been a catalyst for change in many aspects of public policy. We encourage debate, provide evidence and promote a shared understanding of critical global issues*". The OECD launched the Better Life initiative and the program on Measuring Well-Being and Progress to find answers to questions such as "*Are our lives getting better?*", "*How can policies improve our lives?*", "*Are we measuring the right things?*", etc. Thus, it is evident the role of OECD to diplomacy as a policy advisor for well-being based on BLI analysis.

The political and the economic environment influence the well-being. For instance, the implemented environmental policies and the economic conditions (income, unemployment, etc.) affect the quality of life. The OECD's How's Life? 2020 report illustrates that two-thirds of people in OECD countries are exposed to dangerous levels of air pollution. On average the footprint of the OECD residents is increased, only 10.5% of energy consumption is produced by renewable sources and in almost half

of OECD countries thousands of species face extinction. In addition, the report shows that on average the household wealth and the performance of school students in international science tests have fallen. According to the report inequalities persist, with unequal income distribution, insecurity, despair and disconnection affecting large part of the population. In particular, more than 1 in 3 OECD households are financially insecure (household debt exceeds the household disposable income), 7% of people in OECD countries express very low satisfaction and the deaths due to depression exceeded the deaths from homicide and road accidents. The BLI incorporates the aforementioned aspects into the analysis and provides measures and insights for the well-being.

BLI also serves as an international public opinion repository about well-being. The online BLI platform records the priorities and views of citizens from different socio-economic environments worldwide. This interactive communication tool reveals what matters most to the people. For instance, exposure to dangerous levels of fine particulate matter may affect a small part of the population in one region while affecting a larger part in another. Thus, the answers given online can be used to elicit valuable information about the weighting scheme that should be used for the construction of BLI. In this way, the real priorities of people will be incorporated in the BLI and their views will further play a key role in the recommendations and advice to the policy makers.

As the emerging natural and economic risks threaten all aspects of life globally, the governments should adapt and collectively cooperate through international diplomacy to pursue common goals for well-being. Recognizing that the development must balance social, economic and environmental sustainability, the United Nations adopted the Sustainable Development Goals (a collection of 17 global goals) in 2015 for a better and more sustainable future to be achieved by the year 2030. The future of well-being will be ensured by preserving global financial stability and fair competition, stimulating the economic growth, reducing the inequalities and implementing international environmental regulations. The BLI provides measures for the several well-being aspects and demonstrates how policy can be a collaborative process. It enables worldwide comparisons and illustrates the individual issues of each region on which focus must be placed. In this vein, BLI can be employed to determine where resources are needed as well as to examine if policies are underperforming or achieving their strategic goals. Thus, it can straightforwardly serve

as a tool to aid international diplomacy, e.g., United Nations, to reach economic and climate agreements (see Berridge, 2015).

3   METHODS

Mizobuchi (2014) applied the BoD approach to construct the BLI for 34 countries (32 OECD members, Brazil and Russia) for the data of year 2011. The BoD was applied for the aggregation of the eleven topics (level 2), whose scores were estimated by the original averaging formula proposed by the OECD BLIOECD Better Life Index (BLI) initiative.[2] The obtained BLI scores were used to further investigate the link between the countries' well-being and the economic development, as reflected by per capita GDP. However, the approach of Mizobuchi (2014) generates country-specific weights that maximize the performance (composite indicator) of each country, failing in this way to provide a common basis for comparisons among the countries. Mizobuchi (2017) introduced another topic to BLI, apart from the 11 initial topics to account for the sustainability of well-being. Such an addition has been also proposed by OECD as a future complement in the BLI. In contrast to Mizobuchi (2014, 2017) applied the corrected convex non-parametric least squares (C^2NLS) method for constructing the BLI. Barrington-Leigh and Escande (2018) conducted a comparative study of indicators that measure progress and countries' well-being, reviewing the BLI and highlighting its advantages. In the same context, Lorenz et al. (2017) developed BoD based models to estimate the weighting schemes that allow each country to attain the highest possible rank according to its BLI performance. In addition, Peiro-Palomino and Picazo-Tadeo (2018) calculated the BLI based only on ten topics. They used instead the "*Life Satisfaction*" topic for comparison purposes with the calculated BLI. They employed the goal-programming model proposed by Despotis (2002) for the assessment and they also performed hierarchical cluster analysis to group the assessed countries in terms of well-being. However, in these models, compensability among the different components of the indices is assumed, i.e., trade-off relations exist among the topics and a country's low performance in a topic may be "compensated" by a high performance

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[2] The method proposed by OECD for the aggregation of the indicators of level 1 can be found in https://www.oecdbetterlifeindex.org/about/better-life-initiative/#question15.

in another topic. Koronakos et al. (2019) modeled the assessment of BLI as a multiple objective programming (MOP) problem. They developed a hierarchical (bottom-up) procedure to aggregate the components of each level of BLI in separate phases. They also incorporated the public opinion, acquired from the OECD BLI web platform, into the assessment models in the form of weight restrictions. In this way, the effect of compensation imposed by the modeling approach is reduced. Greco et al. (2019b) also employed the ratings provided by people on the OECD BLI web platform for the eleven factors of BLI, but for the estimation of the aggregate societal loss of well-being. For this purpose, for each country they first transformed the performance of the factors into a discrete scale. Then they calculated each individuals' loss in well-being as the distance between the transformed performance in each factor and the collected individuals' views (weights).

3.1 Normalization

As the multilateral indicators are expressed in different units (dollars, years, etc.), the composition of BLI requires a data transformation step, prior to the aggregation of the raw data. The transformation is accomplished by applying the following formula to the original values of the indicators[3]:

$$\frac{ACV - MINOV}{MAXOV - MINOV} \tag{1}$$

When an indicator depicts a negative aspect of well-being (e.g., air pollution) the formula is modified as:

$$1 - \frac{ACV - MINOV}{MAXOV - MINOV} \tag{2}$$

In formulas (1) and (2) ACV denotes the actual country's value, whereas MINOV and MAXOV denote the minimum and maximum observed value among all countries, respectively. The normalization procedure converts the values of the indicators (level 1) in the [0,1] range, where

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[3] The normalization formulas used by OECD for the data of the indicators of level 1 can be found in https://www.oecdbetterlifeindex.org/about/better-life-initiative/#question16.

"0" represents the worst possible performance and "1" the best possible one.

Notice that the normalization procedure described above involves, only for the year under assessment, the minimum and maximum observed values of the indicators from the participating countries. However, Koronakos et al. (2019) noticed that these values may have been changed dramatically among the years. As a result, the dispersion of the indicators' (level 1) values among the years is not considered during the necessary normalization process. They proposed instead to smooth the deviations of indicators' values and to establish cross-year compatibility by incorporating in the normalization process their minimum and maximum observed values[4] across the years (i.e., of the available data of 2013–2017). In this way, the absolute values of the indicators are converted to relative ones. For this purpose, they modified the formulas (1) and (2) accordingly. For the indicators that exhibit positive contribution to the BLI (e.g., Life expectancy, Water Quality, etc.), they employed the following adjusted formula:

$$\frac{ACV - MINOV^{(2013-2017)}}{MAXOV^{(2013-2017)} - MINOV^{(2013-2017)}} \quad (3)$$

Similarly, for the indicators that exhibit negative contribution to the BLI (e.g., Housing Expenditure, Air pollution, etc.), the normalization formula becomes:

$$1 - \frac{ACV - MINOV^{(2013-2017)}}{MAXOV^{(2013-2017)} - MINOV^{(2013-2017)}} \quad (4)$$

where ACV denotes the actual country's value, whereas $MINOV^{(2013-2017)}$ and $MAXOV^{(2013-2017)}$ denote the minimum and maximum observed value among all countries, respectively from 2013 to 2017.

3.2   Aggregation

The common practice adopted in the literature for the construction of three-level hierarchical composite indices such as BLI, is the use of the

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[4] The complete data of the indicators for the years 2013–2017 can be found in the online database of OECD https://stats.oecd.org/Index.aspx?DataSetCode=BLI.

simple arithmetic average for the aggregation of the indicators (level 1). However, Koronakos et al. (2019) focused on the whole hierarchical structure of the index and aggregated the indicators of level 1 as weighted arithmetic averages, where the weights are obtained endogenously from optimization process. They developed a bottom-up procedure to aggregate, in two separate phases, the components of the index. In the first phase of the procedure, they derived through optimization the aggregation scheme of the indicators (level 1) to obtain the values of the topics that lie on the next level (level 2). Then, in the second phase of the procedure, they utilized the values of the 11 topics (level 2) obtained from the first phase, to derive through optimization of the aggregation weighting scheme that constructs the BLI (level 3).

The BoD is a prevailing approach in the literature of composite indices and has been already utilized for the aggregation of the topics (level 2) of BLI (Mizobuchi, 2014). The conventional form of BoD model (5) below, can be characterized as an index maximizing linear programming model that is solved for one country at a time (Despotis, 2005). The composite index h_j for the specific country j ($j = 1,...,n$) derives as the weighted sum $h_j = uY_j$, where $Y_j = (Y_{j1}, Y_{j2}, ..., Y_{jm})^{\mathrm{T}}$ denotes the vector of the m components' values and $u = (u_1, u_2, ..., u_m)$ denotes the vector of the variables used as weights.

$$\max h_{j0} = uY_{j0}$$
$$s.t.$$
$$uY_j \leq 1, \ j = 1, ..., n$$
$$u \geq \varepsilon \tag{5}$$

Model (5) provides a relative measure for a composite index and it is solved for each country individually. Thus, the optimal values u^* of the multipliers vary from country to country. The different country-specific weighting schemes derived by model (5) allow each country to achieve the highest possible score. In this respect, the BoD model (5) lacks a common basis for cross-country comparisons and ranking. Koronakos et al. (2019) argued that a common basis for fair evaluation can be established by finding a common set of multipliers u that will be used to obtain the composite index for each country. They formulated the following multiple objective programming model where the performance of each

country ($h_j = uY_j$) is treated as a distinct objective-criterion:

$$\max \{ h_1 = uY_1, \ldots, h_n = uY_n \}$$
$$s.t.$$
$$uY_j \leq 1, \ j = 1, \ldots, n$$
$$u \geq \varepsilon \tag{6}$$

The MOP (6) can be converted and solved as a single objective program through scalarization. For this purpose, Koronakos et al. (2019) employed the *method of the global criterion* (c.f. Mietinnen, 1999) that is a no-preference method, i.e., no priority is assigned to the objectives. In this method, the distance between some reference point and the feasible objective region is minimized. They selected the vector $e = (1,\ldots,1)$ as the reference point to derive ratings for each country as near as possible to the highest level of the index, i.e. $h_j = 1, j = 1,\ldots,n$. The distance between the reference point and the feasible objective region can be measured by employing different metrics, thus they formulated the L_p problem as follows:

$$\min \left(\sum_{j=1}^{n} |1 - uY_j|^p \right)^{1/p}$$
$$s.t.$$
$$uY_j \leq 1, \ j = 1, \ldots, n$$
$$u \geq \varepsilon \tag{7}$$

The MOP (6) is scalarized via the method of the global criterion by employing the L_1 metric, i.e., $p = 1$ in (7), as follows:

$$\min \sum_{j=1}^{n} \left(1 - uY_j \right)$$
$$s.t.$$
$$uY_j \leq 1, \ j = 1, \ldots, n$$
$$u \geq \varepsilon \tag{8}$$

The single objective model (8), also known as the *min-sum* method, simultaneously minimizes the sum of the deviations (L_1 metric) for

all countries between the performance that they can achieve using the common multipliers and the selected reference point. In other words, the aim of model (8) is to maximize the performances of all countries simultaneously under a common weighting scheme. Model (8) can be straightforwardly transformed to model (9) by introducing the deviation variables ($d_j = 1 - uY_j$) at the constraints and replacing the corresponding terms in the objective function.

$$\min \sum_{j=1}^{n} d_j$$

$$s.t.$$
$$uY_j + d_j = 1, \ \ j = 1, \ldots, n$$
$$u \geq \varepsilon, \, d_j \geq 0 \tag{9}$$

Model (9), as it is equivalent to model (8), is solved only once and provides higher discrimination regarding the performance of the evaluated countries as well as it allows for ranking. This approach can be characterized as fair and democratic since all countries collectively and equally participate in the generation of the optimal set of weights that is commonly used to derive their performance. Notice that the optimal solution of models (8) and (9) is Pareto optimal to the MOP (6).

Koronakos et al. (2019) noted that if the analysis is oriented to the disadvantaged countries to give them the opportunity to be heard, then the L_∞ metric can be utilized, i.e., $p = \infty$ in (7). Also, the L_∞ metric can be used to examine how the countries perform from the viewpoint of the weakest one. In this way, variations on their performances can be detected. Utilizing the L_∞ metric, the model (7) takes the following form:

$$\min \ \max_{j=1,\ldots n} \left[\left| 1 - uY_j \right| \right]$$

$$s.t.$$
$$uY_j \leq 1, \ \ j = 1, \ldots, n$$
$$u \geq \varepsilon \tag{10}$$

Model (10) is also known as the *Tchebycheff* or *min-max* method that is among the most common scalarization methods in multiple criteria optimization. Model (10) can be equivalently transformed to the linear

program (11):

$$\min \delta$$
$$s.t.$$
$$uY_j + \delta \geq 1, \quad j = 1, \ldots, n$$
$$uY_j \quad \leq 1, \quad j = 1, \ldots, n$$
$$u \geq \varepsilon, \; \delta \geq 0 \qquad\qquad (11)$$

Notice that the optimal solution of model (11) is in general weakly Pareto optimal to the MOP (6) (c.f. Yu, 1973). Steuer and Choo (1983) introduced a variant of the *Tchebycheff* method called *augmented Tchebycheff* method, which secures the Pareto optimality of the solutions. This is accomplished by adding to the objective function of model (11) the aggregate of the deviations from the reference point (L_1-*term*), which is called correction or augmentation term. The formulation of the *augmented Tchebycheff* method that guarantees to derive a Pareto optimal solution to model (6) is model (12):

$$\min \delta + \rho \sum_{j=1}^{n} \left(1 - uY_j\right)$$
$$s.t.$$
$$uY_j + \delta \geq 1, \quad j = 1, \ldots, n$$
$$uY_j \quad \leq 1, \quad j = 1, \ldots, n$$
$$u \geq \varepsilon, \; \delta \geq 0 \qquad\qquad (12)$$

In model (12) the parameter ρ is a sufficiently small positive scalar. Model (12) minimizes the distance between the reference point and the feasible objective region by employing the augmented Tchebycheff metric. In model (12), the optimal solution is primarily determined by the largest deviation δ from the reference point, i.e., by the objective (country) with the lowest performance. Thus, the obtained weighting scheme (set of common weights) provides performance measures for all countries from the viewpoint of the weakest one.

3.3 Public Opinion

Mizobuchi (2017) mentioned "*it is particularly difficult to reach consensus on the relative importance of different socio-economic conditions*". Indeed, different weighting schemes provide different scores and country rankings that raise the argument. In the ten Step Guide published by the Competence Centre on Composite Indicators and Scoreboards of the European Commission, it is noted that public opinion polls are often launched to elicit the relative weights, from a societal aspect, for the aggregation of composite indicators. In this context, the OECD BLI web platform prompts people to declare their views on the relative importance of the eleven topics of level 2 to build their own Better Life Index. The preferences expressed by people are stored in a publicly accessible database that enables the cross-country comparisons and aid the OECD to better understand what is most important for the well-being. Thus, as Barrington-Leigh and Escande (2018) noticed, the online platform serves also "*as a research tool because it records user interaction*". Koronakos et al. (2019) argued that although people's authentic responses are subjective judgments, they reveal the true needs and beliefs. Hence, public opinion is the best driver for assessing the countries concerning the well-being, despite the different necessities and cultures that might exist across countries or even within same regions. Including the global responses from all parts of societies, enables to consider equally all the different views in a democratic form of assessment. The public opinion over the significant issues of what makes for a quality life, can and should be employed by policy makers to shape a better picture of well-being across countries, with the ultimate goal to designate and deliver accurate and successful policies.

Similar to Zanella et al. (2015) and Rogge et al. (2017) who introduced weight restrictions in their formulations to deal with the compensability, Koronakos et al. (2019) incorporated the public opinion into the evaluation models (5), (9) and (12) in the form of weight restrictions (see Allen et al., 1997). In this manner, as they noted, they incorporated a non-compensatory preference relation in their assessment. They translated the reported people's views for the eleven topics (level 2) that compose the BLI to absolute limits that the corresponding weights (u) can receive (see Roll et al., 1991). The lower and upper bounds of the weight given to each topic derive from the minimum and maximum values of the responses for each topic. The whole set of the weight restrictions

is denoted with Ω.

$$u \in \Omega \tag{13}$$

Notice that by imposing rational restrictions on the weights' limits, if not eliminates, the compensation among the 11 topics of BLI assumed in the models (5), (9) and (12). Moreover, the incorporation of the weight restrictions Ω into the evaluation models does not allow the variables (weights) to get zero values at optimality. Thus, the constraints $u \geq \varepsilon$ are omitted as redundant. Alternative types of weight restrictions can be also employed, such as assurance region constraints in which upper and lower bounds are imposed on the ratio of pairs of weights (Thompson et al., 1986).

4   ASSESSMENT OF OECD BLI

In this section we apply the two-phase bottom-up approach introduced by Koronakos et al. (2019) for the BLI assessment of 38 countries (35 OECD and 3 non-OECD economies) for the year 2017.

4.1   Normalization of the Raw Data of Indicators (Level 1)

Table 1 summarizes the statistics of the indicators at level 1, as they were rescaled by means of the formulas (3) and (4). The raw data of the indicators can be found in the online database[4] of OECD.

4.2   Calculation of the Topics (Level 1 to Level 2)

The indicators (level 1) are aggregated as weighted arithmetic averages, where the aggregation weighting schemes for the calculation of the values of the next level are derived through optimization. At the first phase of the procedure, models (5), (9) and (12) were applied separately to the normalized values of the indicators (level 1) to derive the aggregation weighting scheme that yields the values of the topics (level 2). As argued in Koronakos et al. (2019), in this way, the rationale and the properties of each modeling approach are conveyed to the whole structure of the composite index. Nine out of eleven topics comprise of more than one indicator, thus each model exclusively was applied to the indicators of each topic so as to obtain its value. Notice that only two topics, namely

Table 1 Descriptive statistics of the data of indicators—Level 1

	Min	Max	Mean	Median	Variance	St.Dev	Skew	Q1	Q3
Dwellings without basic facilities	0	1	0.907	0.984	0.032	0.179	−3.835	0.884	0.997
Housing expenditure	0.063	0.750	0.382	0.375	0.023	0.151	0.138	0.250	0.438
Rooms per person	0	0.947	0.496	0.553	0.062	0.249	−0.152	0.263	0.632
House hold net adjusted disposable income	0.061	1	0.464	0.458	0.052	0.227	0.282	0.283	0.612
House hold net financial wealth	0	1	0.271	0.214	0.050	0.223	1.158	0.094	0.397
Labor market insecurity	0.176	0.974	0.847	0.895	0.027	0.163	−2.686	0.846	0.939
Employment rate	0	1	0.575	0.605	0.036	0.191	−0.765	0.512	0.715
Long-term unemployment rate	0.129	0.999	0.836	0.899	0.037	0.191	−2.555	0.799	0.936
Personal earnings	0.107	1	0.559	0.573	0.062	0.249	−0.005	0.323	0.767
Community	0.258	0.968	0.711	0.726	0.022	0.148	−1.010	0.645	0.806
Educational attainment	0.094	1	0.722	0.789	0.062	0.250	−1.330	0.695	0.887
Student skills	0.044	0.912	0.646	0.704	0.044	0.211	−1.537	0.613	0.767
Years in education	0.099	1	0.461	0.451	0.038	0.196	0.478	0.327	0.563
Air pollution	0.500	1	0.792	0.780	0.014	0.118	−0.232	0.710	0.875
Water quality	0.182	1	0.696	0.727	0.039	0.198	−0.579	0.541	0.868
Stakeholder engagement for developing regulations	0	1	0.463	0.481	0.066	0.258	−0.019	0.259	0.667
Voter turnout	0.043	0.957	0.501	0.489	0.064	0.254	0.013	0.332	0.668
Life expectancy	0.022	1	0.839	0.899	0.030	0.173	−3.151	0.789	0.939
Self-reported health	0.050	0.967	0.624	0.667	0.054	0.233	−0.744	0.533	0.767
Life Satisfaction	0.032	0.903	0.590	0.629	0.063	0.250	−0.458	0.387	0.831
Feeling safe walking alone at night	0	0.964	0.608	0.641	0.061	0.247	−0.726	0.465	0.818
Homicide rate	0	1	0.900	0.971	0.040	0.200	−3.326	0.948	0.985
Employees working very long hours	0.269	1	0.814	0.868	0.029	0.170	−1.617	0.734	0.921
Time devoted to leisure and personal care	0.186	1	0.670	0.684	0.027	0.163	−0.924	0.593	0.742

the "Life Satisfaction" and the "Community", consist of one indicator. Therefore, the normalized values of these indicators directly become the values of the corresponding one-dimensional topics. We provide descriptive measures for the values of the topics (level 2) as derived by each model in Tables 2 and 3.

Table 2 Average score for each topic as derived by each model

Model	HO	IW	JE	SC	ES	EQ	CG	HS	SW	PS	WL
BoD model (5)	0.936	0.465	0.902	0.711	0.824	0.818	0.686	0.887	0.590	0.903	0.833
Min-sum model (9)	0.907	0.464	0.878	0.711	0.774	0.792	0.604	0.864	0.590	0.900	0.817
Min-max model (12)	0.700	0.387	0.851	0.711	0.698	0.756	0.592	0.760	0.590	0.640	0.817

HO: Housing, IW: Income, JE: Jobs, SC: Community, ES: Education, EQ: Environment, CG: Civic engagement, HS: Health, SW: Life Satisfaction, PS: Safety, WL: Work-Life Balance

Table 3 Standard deviation of scores for each topic as derived by each model

Model	HO	IW	JE	SC	ES	EQ	CG	HS	SW	PS	WL
BoD model (5)	0.091	0.226	0.161	0.148	0.204	0.110	0.214	0.121	0.250	0.198	0.163
Min-sum model (9)	0.179	0.227	0.173	0.148	0.247	0.118	0.236	0.175	0.250	0.200	0.169
Min-max model (12)	0.129	0.214	0.185	0.148	0.202	0.129	0.218	0.175	0.250	0.252	0.169

HO: Housing, IW: Income, JE: Jobs, SC: Community, ES: Education, EQ: Environment, CG: Civic engagement, HS: Health, SW: Life Satisfaction, PS: Safety, WL: Work-Life Balance

Table 2 presents the average score of all countries in each topic as obtained from each model. Analogously, Table 3 exhibits the standard deviation of all counties' scores per topic in each model separately. Notably, in Community (SC) and Life Satisfaction (SW) all models provide the same average score and standard deviation. This is attributed to the fact that these topics consist of a single indicator. Thus, independently of the model employed, the countries' scores on these topics coincide with the levels of the corresponding normalized indicators. Furthermore, as the BoD (5) grants the flexibility to each country to maximize its performance, it provides higher scores compared to the other models. Consequently, the average scores derived by BoD (5) are the highest ones with the lowest standard deviations in all indicators apart from Income (IW) and Education (ES), as presented in Table 3. Regarding the min-sum model (9) and the min-max model (12), the former yields higher average scores than the latter in all topics. This is attributed to the "*democratic*" and "*fair*" character of the min-sum model (9) where all countries together and equally decide the optimal solution. On the other hand, in min-max model (12) the country with the poorest performance plays a decisive role and primarily decides the optimal solution.

4.3   *Incorporation of Public Opinion*

To date, more than 132,566 users from 218 countries have shared their views on the OECD web platform. The responses are updated daily, and grouped by country, age and gender. The 57% of the respondents are male while the 43% of them are female. Also, the respondents are divided into seven age groups, namely <15, 15–24, 25–34, 35–44, 45–54, 55–64 and >65. Most of the respondents belong to the groups 15–24 (33%) and 25–34 (28%). The complete list of the responses of people worldwide is publicly available at the web platform (oecdbetterlifeindex.org/bli/rest/indexes/stats/country). In this study, we have chosen to include the 117,434 responses that derive from the citizens of the 35 members of the OECD and the 3 partner countries for which OECD provides data and metrics. Table 4 presents the normalized weights for the 11 topics (level 2), which are retrieved from the responses of the 38 countries that participate in the assessment. The last row of Table 4 contains the representative (total) weights of the worldwide responses as provided by OECD.

Table 4 Normalized weights retrieved from OECD about the topics of level 2

	Country	HO	IW	JE	SC	ES	EQ	CG	HS	SW	PS	WL
1	Australia	0.090	0.087	0.084	0.074	0.098	0.083	0.063	0.103	0.099	0.092	0.127
2	Austria	0.091	0.083	0.086	0.080	0.098	0.095	0.068	0.107	0.103	0.097	0.091
3	Belgium	0.094	0.087	0.087	0.079	0.100	0.092	0.065	0.107	0.103	0.092	0.094
4	Canada	0.090	0.088	0.089	0.080	0.099	0.091	0.064	0.107	0.104	0.096	0.093
5	Chile	0.090	0.089	0.092	0.076	0.106	0.092	0.073	0.104	0.096	0.090	0.093
6	Czech Republic	0.085	0.092	0.092	0.076	0.098	0.094	0.068	0.104	0.103	0.098	0.090
7	Denmark	0.083	0.081	0.087	0.081	0.103	0.094	0.073	0.102	0.112	0.091	0.094
8	Estonia	0.096	0.090	0.090	0.078	0.099	0.097	0.067	0.103	0.100	0.099	0.083
9	Finland	0.087	0.083	0.085	0.079	0.099	0.098	0.069	0.105	0.107	0.097	0.091
10	France	0.094	0.087	0.091	0.088	0.099	0.092	0.062	0.108	0.099	0.088	0.093
11	Germany	0.090	0.084	0.086	0.083	0.099	0.092	0.068	0.105	0.109	0.090	0.094
12	Greece	0.086	0.090	0.092	0.077	0.102	0.092	0.066	0.110	0.100	0.094	0.090
13	Hungary	0.092	0.090	0.085	0.084	0.096	0.093	0.062	0.101	0.105	0.099	0.095
14	Iceland	0.097	0.089	0.090	0.081	0.101	0.085	0.064	0.108	0.094	0.104	0.087
15	Ireland	0.088	0.089	0.089	0.083	0.099	0.087	0.068	0.101	0.111	0.085	0.100
16	Israel	0.094	0.103	0.088	0.077	0.103	0.082	0.064	0.107	0.101	0.088	0.093
17	Italy	0.086	0.082	0.093	0.083	0.098	0.095	0.072	0.104	0.103	0.088	0.095
18	Japan	0.090	0.088	0.087	0.081	0.098	0.087	0.063	0.103	0.102	0.111	0.090
19	Korea	0.093	0.089	0.088	0.080	0.096	0.086	0.069	0.097	0.107	0.101	0.094
20	Latvia	0.087	0.094	0.087	0.080	0.094	0.097	0.069	0.093	0.103	0.097	0.097
21	Luxembourg	0.089	0.098	0.094	0.078	0.092	0.093	0.062	0.106	0.101	0.093	0.092
22	Mexico	0.091	0.091	0.092	0.076	0.104	0.088	0.074	0.100	0.097	0.093	0.092
23	Netherlands	0.093	0.085	0.084	0.079	0.099	0.092	0.067	0.105	0.111	0.092	0.095
24	New Zealand	0.088	0.085	0.086	0.081	0.099	0.096	0.067	0.102	0.108	0.091	0.097
25	Norway	0.093	0.088	0.090	0.079	0.095	0.092	0.065	0.107	0.105	0.093	0.095
26	Poland	0.090	0.094	0.091	0.078	0.101	0.086	0.061	0.098	0.109	0.098	0.095

	Country	HO	IW	JE	SC	ES	EQ	CG	HS	SW	PS	WL
27	Portugal	0.088	0.084	0.093	0.078	0.096	0.090	0.069	0.104	0.104	0.099	0.096
28	Slovak Republic	0.085	0.088	0.092	0.081	0.096	0.093	0.068	0.104	0.104	0.097	0.091
29	Slovenia	0.089	0.084	0.087	0.083	0.099	0.102	0.065	0.101	0.099	0.100	0.092
30	Spain	0.086	0.084	0.091	0.078	0.102	0.087	0.075	0.109	0.097	0.094	0.097
31	Sweden	0.088	0.084	0.089	0.079	0.097	0.096	0.070	0.105	0.107	0.090	0.095
32	Switzerland	0.090	0.089	0.089	0.083	0.097	0.092	0.064	0.103	0.106	0.092	0.093
33	Turkey	0.091	0.093	0.088	0.083	0.099	0.090	0.073	0.100	0.095	0.094	0.094
34	United Kingdom	0.091	0.089	0.090	0.079	0.098	0.091	0.062	0.105	0.111	0.086	0.097
35	United States	0.086	0.087	0.087	0.081	0.099	0.092	0.063	0.104	0.112	0.091	0.098
36	Brazil	0.090	0.087	0.089	0.074	0.107	0.087	0.065	0.104	0.102	0.103	0.092
37	Russia	0.096	0.095	0.090	0.080	0.094	0.088	0.074	0.100	0.095	0.096	0.092
38	South Africa	0.095	0.093	0.091	0.074	0.096	0.088	0.061	0.100	0.106	0.097	0.100
	Total	0.090	0.088	0.089	0.080	0.099	0.090	0.066	0.104	0.104	0.092	0.097

Figure 2 depicts the variability of the weights presented in Table 4, where the symbol "o" denotes outlier and the symbol "*" denotes extreme outlier. As shown for example, responses originated from Australia (numbered 1 in Table 4) give the highest priority to Work–Life Balance (WL), which is characterized as extreme outlier. As can be seen, the topic Civic Engagement (CG) has been assigned the lowest weight values.

The public opinion can be incorporated into the evaluation models by translating it into direct weight restrictions. In Table 5 we present the lower and upper bounds that the weight of each topic can receive. These bounds derive from the minimum and maximum values of each column (topic) of Table 5. The whole set of the weight restrictions is denoted with Ω (13).
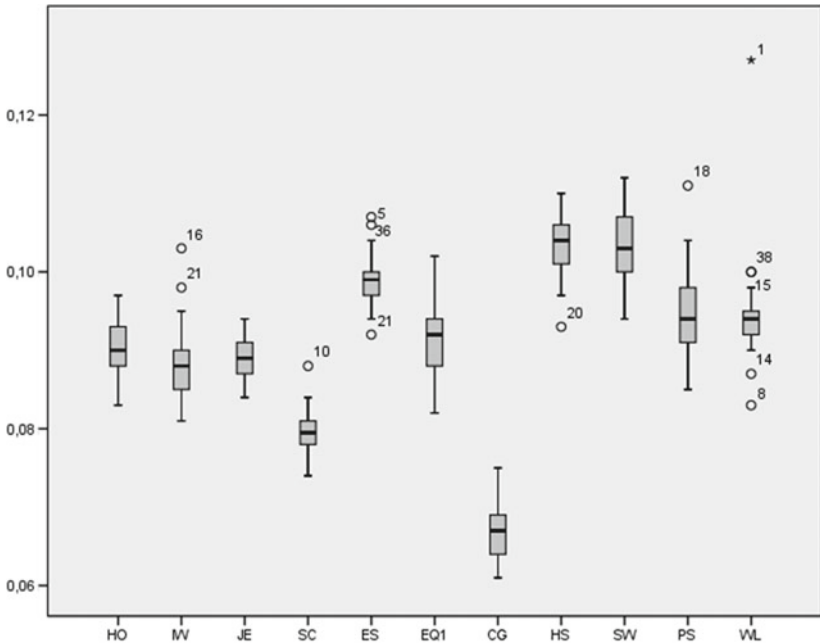

Fig. 2 Boxplots of the weights of the 11 topics derived by the public opinion

Table 5 Lower and upper bounds of the weights of the eleven topics—Level 2

	HO	IW	JE	SC	ES	EQ	CG	HS	SW	PS	WL
Lower Bound	0.083	0.081	0.084	0.074	0.092	0.082	0.061	0.093	0.094	0.085	0.083
Upper Bound	0.097	0.103	0.094	0.088	0.107	0.102	0.075	0.110	0.112	0.111	0.127

HO: Housing, IW: Income, JE: Jobs, SC: Community, ES: Education, EQ: Environment, CG: Civic engagement, HS: Health, SW: Life Satisfaction, PS: Safety, WL: Work-Life Balance

4.4   Calculation of the BLI (Level 2 to Level 3)

At the second phase of the bottom-up procedure we employ, similar to the first phase, the models (5), (9) and (12) derive the BLI for each country under each different concept and draw comparisons. However, at this phase we incorporate into the models (5), (9) and (12) the weight restrictions Ω described in Table 5.

In Table 6, we present the results obtained by applying each of the aforementioned models to the corresponding data of the topics that derived in the first phase of the bottom-up procedure. The BLI scores of BoD model (5) with the weight restrictions Ω as well as the ranking are presented in column 4 of Table 6. Similarly, the column 5 presents the BLI scores and the ranking derived by the min-sum model (9) with the weight restrictions Ω. The column 6 of Table 6 exhibits the BLI scores and the ranking that obtained by applying the min-max model (12) with the weight restrictions Ω. For comparison purposes, we also present in column 3 of Table 6 the results obtained by applying the BoD model (5) without the weight restrictions Ω. In addition, the second column of Table 6, exhibits the ranking of the countries obtained directly from the OECD platform given the same importance to the 11 topics. Notice that the online platform does not provide the BLI scores of the countries, but only their rank depending on the weighting scheme given by the user.

The conventional BoD model (5) without the weight restrictions Ω ranks many countries in the first position, thus the comparisons with the ranking provided from the OECD web platform cannot be safely drawn. On the contrary, as we observe from Table 6, the rankings derived by models (5), (9) and (12) with the weight restrictions Ω are close to the ranking provided from the OECD web platform. In these four rankings Norway is ranked first while South Africa is ranked last. Comparing the

Table 6 BLI scores—Level 3

Country	OECD ranking with equal importance	BoD model (5) Ranking		BoD model (5) with Ω Ranking		Min-sum model (9) with Ω Ranking		Min-max model (12) with Ω Ranking	
Australia	(3)	1	(1)	0.992	(4)	0.984	(5)	0.925	(7)
Austria	(17)	0.998	(26)	0.940	(14)	0.912	(16)	0.850	(14)
Belgium	(12)	1	(1)	0.935	(15)	0.917	(15)	0.865	(12)
Canada	(5)	1	(1)	0.991	(5)	0.990	(2)	0.942	(3)
Chile	(31)	0.898	(37)	0.747	(31)	0.729	(31)	0.638	(31)
Czech Republic	(21)	1	(1)	0.889	(19)	0.880	(19)	0.755	(22)
Denmark	(2)	1	(1)	0.997	(3)	0.986	(4)	0.935	(5)
Estonia	(22)	1	(1)	0.844	(24)	0.837	(22)	0.747	(23)
Finland	(9)	1	(1)	0.985	(8)	0.990	(2)	0.923	(8)
France	(18)	1	(1)	0.904	(18)	0.883	(18)	0.786	(19)
Germany	(13)	1	(1)	0.956	(12)	0.949	(11)	0.879	(11)
Greece	(35)	0.986	(30)	0.716	(34)	0.705	(34)	0.565	(35)
Hungary	(32)	0.968	(34)	0.745	(33)	0.738	(30)	0.622	(34)
Iceland	(7)	1	(1)	0.974	(11)	0.960	(8)	0.913	(9)
Ireland	(15)	1	(1)	0.935	(15)	0.910	(17)	0.844	(15)
Israel	(24)	0.989	(29)	0.853	(22)	0.832	(23)	0.759	(21)
Italy	(25)	0.985	(31)	0.843	(25)	0.807	(27)	0.690	(26)
Japan	(23)	1	(1)	0.837	(26)	0.816	(26)	0.694	(25)
Korea	(29)	1	(1)	0.800	(28)	0.764	(28)	0.671	(28)
Latvia	(30)	0.984	(32)	0.762	(30)	0.764	(28)	0.661	(29)
Luxembourg	(14)	1	(1)	0.986	(7)	0.952	(9)	0.863	(13)
Mexico	(37)	1	(1)	0.628	(37)	0.613	(37)	0.558	(37)

Country	OECD ranking with equal importance	BoD model (5) Ranking		BoD model (5) with Ω Ranking		Min-sum model (9) with Ω Ranking		Min-max model (12) with Ω Ranking	
Netherlands	(10)	1	(1)	0.975	(9)	0.935	(12)	0.910	(10)
New Zealand	(11)	1	(1)	0.947	(13)	0.931	(13)	0.841	(16)
Norway	(1)	1	(1)	1	(1)	1	(1)	0.973	(1)
Poland	(27)	0.996	(27)	0.828	(27)	0.826	(24)	0.709	(24)
Portugal	(28)	0.973	(33)	0.775	(29)	0.720	(33)	0.643	(30)
Slovak Republic	(26)	0.993	(28)	0.846	(23)	0.841	(21)	0.690	(26)
Slovenia	(20)	1	(1)	0.877	(20)	0.863	(20)	0.808	(18)
Spain	(19)	1	(1)	0.865	(21)	0.825	(25)	0.776	(20)
Sweden	(4)	1	(1)	0.990	(6)	0.981	(6)	0.943	(2)
Switzerland	(6)	1	(1)	0.998	(2)	0.976	(7)	0.936	(4)
Turkey	(36)	0.950	(35)	0.677	(35)	0.623	(36)	0.565	(35)
United Kingdom	(16)	1	(1)	0.915	(17)	0.918	(14)	0.831	(17)
United States	(8)	1	(1)	0.975	(9)	0.952	(9)	0.935	(5)
Brazil	(34)	0.909	(36)	0.668	(36)	0.660	(35)	0.626	(32)
Russia	(33)	1	(1)	0.747	(31)	0.725	(32)	0.626	(32)
South Africa	(38)	0.752	(38)	0.515	(38)	0.358	(38)	0.364	(38)

rankings obtained from model (12) with the Ω and the OECD web platform, we observe slight differences, e.g., Australia 7/3, Austria 14/17 and Israel 21/24. The major differences between the ranking of model (5) with the Ω and the ranking of the OECD web platform, are detected for Luxembourg 7/14, Belgium 15/12 and Iceland 11/7. The major differences between the ranking of model (9) with the Ω and the ranking of the OECD web platform, are detected for Finland 2/9, Spain 25/19, Luxembourg 9/14, Portugal 33/28 and Slovak Republic 21/26.

As expected, the conventional BoD model (5) yields the highest possible score for each country (the average score is 0.984) and lacks discriminating power since 25 countries out of the 38 are deemed as BLI efficient. On the contrary, the inclusion of public opinion with the form of weight restrictions Ω in the BoD model (5), imposes limits to the trade-offs among the 11 topics of BLI and reduces drastically the compensation among them. Indeed, the BoD model (5) with the weight restrictions Ω identifies only one country as BLI efficient, namely Norway, and the obtained average score is considerably lower than the one derived from the BoD model (5). There is a reduction of 12.1% (from 0.984 to 0.865) between the average scores obtained from the BoD model (5) and the BoD model (5) with the weight restrictions Ω. The incorporation of the weight restrictions Ω improves the discriminating power of the BoD model (5). Similarly, from the results of models (9) and (12) we deduce that the weight restrictions Ω play a key role in the assessment. In Table 7 we provide the average score, the standard deviation of the scores and the number of the BLI efficient countries derived by each model.

Table 7 No of BLI efficient countries, average score and standard deviation derived by each model

	BoD model (5)	BoD model (5) with Ω	Min-sum model (9) with Ω	Min-max model (12) with Ω
No of BLI efficient countries	25	1	1	0
Average score	0.984	0.865	0.843	0.770
Standard deviation of scores	0.045	0.121	0.137	0.143

The optimal solution of the min-sum model (9) is decided collectively by all countries, i.e., all countries are assessed under a common weighting scheme. Thus, the min-sum model (9) generates lower scores than the BoD approach and has higher discriminating power. Indeed, the min-sum model (9) with Ω deems as BLI efficient only one country (namely Norway) and on average yields lower scores compared to the BoD model (5) with Ω. In general, the BLI scores derived from the min-sum model (9) with Ω are lower than the scores of BoD model (5) with Ω, the average reduction of the BLI scores is 2.82%, with a significant reduction of 30.5% to the performance of South Africa (0.358 vs 0.515). However, for three countries the BLI scores of the former are higher, namely for Finland (0.99 (2) vs 0.985 (8)), Latvia (0.764 (28) vs 0.762 (30)) and United Kingdom (0.918 (14) vs 0.915 (17)). This clearly occurs because in the bottom-up procedure each model is separately applied to all levels of the BLI. As a result, in the second phase of the bottom-up procedure each model is applied to different data (values of topics). Notice that the values of the topics (level 2) are derived in the first phase of the bottom-up procedure, by applying separately each model to the values of the indicators (level 1). Thus, the resulting values of the topics (level 2) obtained from the different approaches are generally different.

The BLI scores derived from the min-max model (12) with Ω, are in average considerably lower than the ones obtained from the other approaches, for instance we observe an average reduction of 11.03% and 8.86% in comparison with the BoD model (5) with Ω and the min-sum model (9) with Ω, respectively. The scores obtained from the min-max model (12) with Ω are remarkably decreased for all countries as compared with the corresponding ones derived by the BoD model (5) with Ω. For instance, there is a significant reduction on the performance of Greece by 21% (0.565 vs 0.716) and Slovak Republic by 18% (0.69 vs 0.846). Also, the scores obtained from the min-max model (12) with Ω are decreased for all countries but one, namely South Africa (0.364 vs 0.358), as compared with the corresponding ones obtained from the min-sum model (9) with Ω. Again, we spot significant reduction on the performance of some countries, for instance the performance of Greece is decreased by 20% (0.565 vs 0.705) and the one of Italy by 18% (0.69 vs 0.807).

The discrepancies on the BLI scores derived by models (9) and (12), with the weight restrictions Ω, are clearly justified by the different optimality criterion of each model. Although each model yields a common

optimal solution for all the countries, these solutions are generally different. The optimal solution of model (9) with Ω is absolutely determined by all countries, since all the constraints, except the ones imposed by the weight restrictions, should structurally be binding at optimality. On the other hand, the optimal solution of the min-max model (12) with Ω is determined by the country whose performance has the largest deviation from the selected reference point (ideal rating), i.e., the binding constraint corresponds to South Africa. Clearly, South Africa plays a key role in model (12), although we did not assign any priority to this country. This holds because it is a structural property of model (12) to give the opportunity to the weakest country to be heard and let the optimal solution to be primarily decided by the country with the poorest performance. Thus, the obtained weighting scheme provides performance measures for all countries from the viewpoint of the weakest one. This justifies also the reduction in the performance in all other countries than South Africa. Obviously, this effect is mitigated to some extent by bringing into play the views of people about well-being, i.e., the weight restrictions Ω. This happens because the voice of the rest countries can be still heard in model (12) via the weight restrictions Ω. Indeed, the BLI scores and ranking derived by model (12) with Ω indicate that Norway is still ranked first even though the weighting scheme is primarily decided by the weakest country (South Africa) that is ranked at the last position. The South Africa clearly does not act like a benchmark for Norway, since model (12) with Ω does not deem any country as BLI efficient. This is attributed to the impact of the weight restrictions Ω. Notice that when the weight restrictions are omitted from model (12), at optimality, only Australia and Norway are deemed as BLI efficient, which are also the *benchmarks* of South Africa in this case.

A general observation is that the BLI scores obtained from all models as well as the rankings differentiate. However, for the most countries we do not observe great differences on the rankings generated by models (9) and (12), with the weight restrictions Ω. Considerable differentiations are observed for Finland (2/8), Luxembourg (9/13) and Switzerland (7/4). Thus, it is concluded that the incorporation of the public opinion, in the form of the weight restrictions Ω, restrain significantly the flexibility of the models and play a crucial role to the assessment of BLI. Notice that these models without the weight restrictions yield very different scores and rankings. Figure 3 provides a schematic representation of the BLI scores derived by the models (9) and (12) with the weight restrictions Ω.
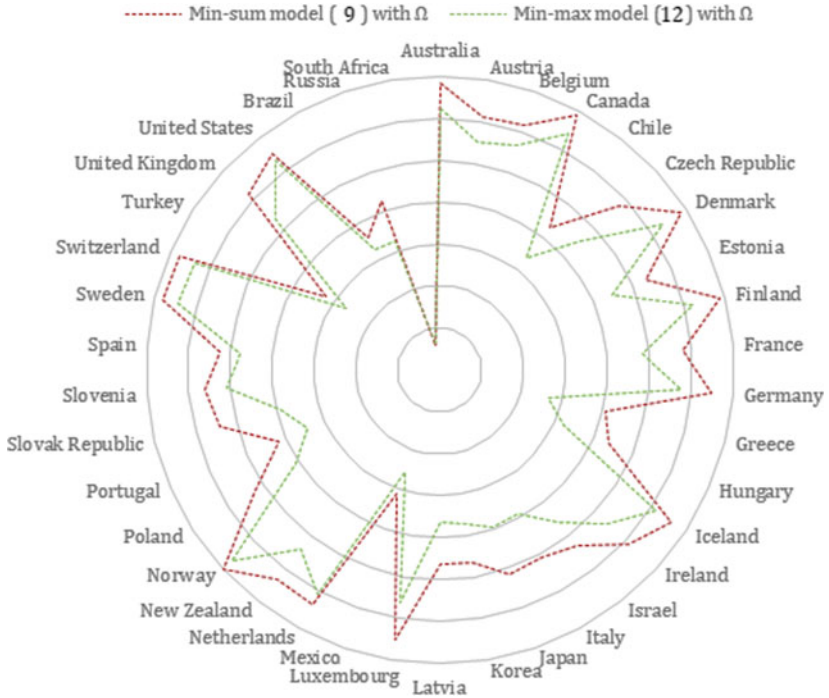
Fig. 3 BLI scores as derived by models (9) and (12) with Ω

The results reveal that there is a clear divide between the Nordic countries as well as Switzerland, Australia and Canada which achieve high BLI scores and the rest of countries that generally achieve relatively low BLI scores. The results verify the objective reality of the balanced economic growth with the well-being in the aforementioned countries. In Fig. 4 we present the countries ranked in Top 10 by models (5), (9) and (12) with the weight restrictions Ω. It is noteworthy that the top five rankings provided by the above mentioned models include only eight countries. Notice that the Southern and Eastern European countries are absent from the Top 10 as well as the countries from Asia, South America and Africa.

Based on the analysis of the results and the characteristics of the min-sum model (9) with Ω and the min-max model (12) with Ω, we propose the former for the evaluation of BLI as it is more democratic
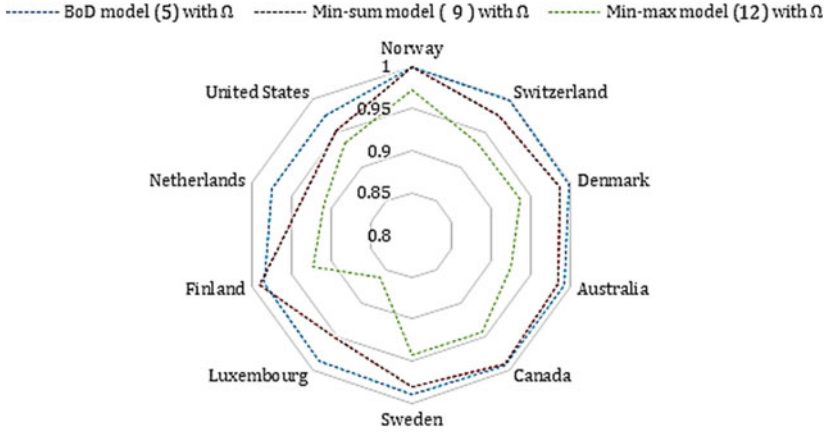
Fig. 4 Top 10 countries

than the latter one. It also establishes a common basis for fair evalua-tion assessment, where the weighting scheme is determined jointly by all the countries and none of them is favored. In addition, the min-sum model (9) with Ω proves to have higher discriminating power than the BoD model (5). As more revealing than mere numbers is the full picture of the 38 countries under evaluation, Fig. 5 exhibits a visualization of their performance as derived by the min-sum model (9) with Ω. In the heat map of Fig. 5 the darker colors indicate high performance while the brighter colors indicate low performance.
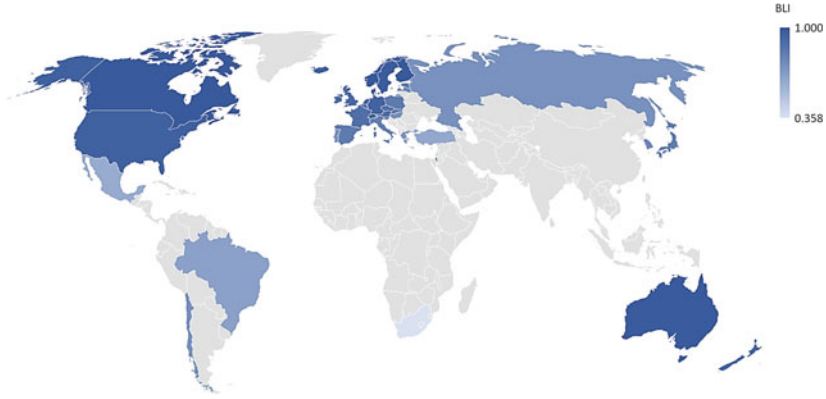
Fig. 5 Heat map of the BLI performance of the 38 countries provided by the min-sum model (10) with Ω

5   Conclusion

In this chapter we presented the OECD Better Life Index that covers several socio-economic aspects and facilitates the better understanding of what drives well-being of people. We discussed the three-level hierarchical structure of the index and we presented the hierarchical bottom-up procedure, proposed by Koronakos et al. (2019), for the aggregation of the components of BLI that lie on different levels. In the context of this approach, the values of each topic (level 2) are obtained from optimization process, instead of commonly aggregating with equal weights the indicators (level 1) that they comprise. Also, we discussed the normalization issues for the indicators (level 1) stemming from possible extreme variations of their values between the years. We showed that the incorporation of data from previous years into the normalization process, absorbs the possible discrepancies. In addition, we demonstrated that the real view of people, captured from the global responses in the web platform of OECD BLI, can be translated to weight restrictions and incorporated into the assessment models. In this way, a non-compensatory preference relation for the weights of the topics was specified. Also, we showed that the incorporation of public opinion can effectively drive the optimization process and depict the collective preferences to the BLI scores.

We illustrated that the assessment of BLI can be modeled as a MOP problem, where the performance of each country is treated as a distinct objective-criterion. The scalarizing methods that can be applied for the MOP have different properties and thus can be employed for different scenarios. We applied the discussed modeling approaches to the data of 38 countries (35 OECD and 3 Non-OECD economies) for the year 2017. Each approach was applied to all levels of BLI to examine how the performance of each country is affected under the different concepts. Among the employed models, we propose the use of the min-sum model (9), because it establishes a "*fair*" and "*democratic*" assessment, where the aggregation weighting scheme of the components of the index is decided collectively and equally by all countries.

Given the global concern for the countries to improve the quality of life for their citizens, the concept of BLI can be applied both to international and national level, e.g., among regions, municipalities, etc. The proposed approach for the BLI identifies, based on the real priorities of people, the different parts of the global society that need improvement. In this respect, BLI illustrates the true-life conditions and needs. Thus, it can be employed to examine the performance of the implemented policies and to determine where resources are needed. These results can be further utilized by the international diplomacy to promote the international consensus and reach economic and environmental agreements.

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