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Incorporating Sustainability Concerns in the Better Life Index:
Application of Corrected Concave Least Squares Method

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Abstract

The OECD recently released a comprehensive set of 11 well-being indicators, the so-called Better Life Index (BLI), for 36 countries. The BLI covers a wide range of socio-economic aspects of life, which are essential to well-being. This well-being dataset allows us to compare countries' overall well-being. However, in spite of the BLI's wider coverage of variables, it fails to consider sustainability concerns. If two countries are characterized by the same socio-economic life circumstances, they are evaluated equally in terms of current well-being. However, once we incorporate sustainability concerns into the international comparison, the country that can sustain good-life circumstances for future generations is appreciated better. This study provides a practical proposal for comparing overall well-being by incorporating sustainability concerns. Using the World Bank's adjusted net savings data as a sustainability indicator, we add an extra dimension to the BLI. Then, we apply a composite indicator and aggregate these 12 indicators for each country into a single number. Moreover, we improve the current method for constructing composite indicators by adopting corrected concave non-parametric least squares (C^2NLS). It is a typical problem in a non-parametric approach based on linear programming for countries' scores of composite indicators to become equal and their performance cannot be distinguished. This becomes even more severe if the number of sample countries is small or the number of aggregated indicators is large, which is the case of the present study dealing with 12 indicators for 36 countries. The use of C^2NLS overcomes this problem and allows us to order all countries in the sample completely. The empirical results show that the introduction of a sustainability index for comparisons does not change countries' overall rankings significantly. However, it certainly changes the ranking of some countries in both directions.

Keywords: Sustainability, Composite Indicators, Better Life Index, Data Envelopment Analysis, Benefit of the Doubt Approach

1. Introduction

Per capita GDP has long been used as a proxy measure of well-being. However, it is now widely recognized that income data provide only a partial perspective on the array of factors that affect people's lives. Given the problems with using GDP per capita as a measure of well-being, many researchers have been searching for alternative measures. In particular, the importance of incorporating a wider range of socio-economic conditions rather than income alone is now widely recognized. Drawing upon the recommendations for research on economic measurement problems by Stiglitz et al. (2009), the OECD identified 11 dimensions as being essential to well-being. The dimensions cover material living conditions, such as income and wealth, as well as quality of life (QOL), such as community, environment, and work–life balance. These dimensions are explored and analysed in detail by the OECD (OECD, 2011). The OECD released 11 types of well-being indicators, known as the OECD Better Life Index (BLI), which covers the 34 OECD member countries and two non-member countries.[1] However, evaluation of overall well-being by summarizing the 11 individual indicators is left to users of the statistics.[2]

The 11 well-being indicators allow us to compare countries by the comprehensive well-being of their populations. However, there is an important component missing from these indicators, namely, sustainability. While the 11 well-being indicators capture the well-being of the current population, it is also a critical issue whether current well-being can be sustained in the future.

There is much in common between, on the one hand, the literature and debates on measures of well-being and, on the other hand, those of sustainability.[3] Levels of well-being are essentially what sustainability advocates would like to sustain. Thus, it is necessary to measure well-being before discussing its sustainability. On the other hand, without sustainability concerns, a country that guarantees the current generation better life circumstances by depleting natural resources at the cost of future generations is evaluated similarly to another country that sustains current well-being in the future, as long as the well-being of the current generation is the same in both countries. This, however, is entirely unconvincing. While the OECD concedes it is necessary to introduce sustainability concerns into the BLI, this has been left as a future issue. The present study attempts to provide a practical proposal on how to measure well-being by incorporating sustainability concerns. First, we add an extra indicator of sustainability concerns to the 11 well-being indicators of the BLI. Second, we aggregate these 12 indicators by the composite indicators.

As Dasgupta (2001) and Arrow et al. (2004) advocate, the productive base of economies, which consists of produced and natural capital and intangible assets, determines the well-being of people. Thus, a smaller productive base predicts lower well-being of future generations. The World Bank's adjusted net savings (World Bank, 2011), which are considered a good measure of sustainability, capture the change in the productive base. Thus, we define the sustainability indicator by the adjusted net savings.

[1] There were 34 countries covered in 2011. A revised dataset released in 2012 includes 36 countries, incorporating Brazil and Russia.

[2] *Your Better Life Index* (http://www.oecdbetterlifeindex.org/) was designed as an interactive tool that allows users to assign the importance of each of the 11 topics and track the performance of countries.

[3] However, the two strands of research, such as measures of well-being and sustainability, tend to have been separated.

Composite indicators are used in order to measure multidimensional concepts, which are characterized by multiple individual indicators. Since individual indicators may trend in different directions to each other, the set of multiple indicators itself is not enough to provide an overall picture of multidimensional concepts across countries. Among a number of techniques to construct the composite indicator, the 'benefit of the doubt' (BOD) approach, which has received increasing attention from researchers, avoids subjectivity in the determination of weights (Mahlberg and Obersteiner, 2001; Cherchye et al., 2004, 2007; Despotis, 2005; OECD, 2008). Under BOD, the weights are country-specific and endogenously determined such that they maximize the value of each country's resulting composite indicator. Thus, larger weights are given to the individual indicators (topics of well-being) on which each country performs well. The core idea is that a good relative score of a country on an individual indicator shows that it considers the individual indicator as relatively important. Therefore, for international comparisons based on BOD, a country cannot attribute the lower score of its composite indicator to a harmful or unfair weighting scheme.

BOD is rooted in data envelopment analysis (DEA), which is designed to compute efficiency indices. DEA is an established technique to measure the relative efficiency of decision-making units based on inputs and outputs of units in a sample. It measures the efficiency of each unit by its distance from the production frontier, which is represented by the best-practice units. Formally, BOD is tantamount to the input-oriented DEA model, with all individual indicators as outputs and a 'dummy input' equal to one for all countries.[4]

A well-known problem associated with DEA (thus, BOD) is that it often fails to differentiate the performance of all decision-making units completely, with the result that some units are ranked equally. This arises from the DEA procedure of constructing the production frontier based on a linear-programming technique. Kuosmanen and Johnson (2010) introduce an alternative method, namely, corrected concave non-parametric least squares (C^2NLS) for computing the efficiency measure.[5] C^2NLS constructs the production frontier based on quadratic linear programming. This new method offers certain advantages to the existing DEA. Kuosmanen and Johnson (2010) show that the estimates based on C^2NLS are consistent, and asymptotically unbiased, and yield smaller mean-squared error than the corresponding DEA efficiency estimators. In addition to these advantages, C^2NLS has better discriminatory power than DEA, which allows for the complete ordering of the efficiency scores of all the units in a sample. As suggested by Kuosmanen and Johnson (2010), the C^2NLS method can be used for estimating shadow prices, setting performance targets, and identifying benchmarks in a similar fashion to the standard DEA. To the best of our knowledge, this is the first study that applies C^2NLS to construct composite indicators.

Mizobuchi (2014) applies the BOD method to construct a composite indicator which aggregates the 11 well-being indicators of the BLI. However, the problem of equal rankings among many countries associated with the BOD is established but left unresolved. The more indicators the composite indicator aggregates, the more countries are likely to be ranked indifferently. The procedure proposed by the present study would resolve this problem. Other than GDP per capita, the United Nations' Human

[4] Lovell et al. (1995) interpret the dummy input as a helmsman that pursues several policy objectives.

[5] Constructing the production frontier based on C^2NLS is part of the entire process of estimating the efficiency measure known as stochastic non-parametric envelopment of data (StoNED). See Kuosmanen (2008) and Kuosmanen and Johnson (2010).

Development Index (HDI) is the most popular measure of well-being. In addition, it is a composite indicator which aggregates fewer aspects than ours, such as income, education, and health. In the last 2 decades, a series of papers has introduced sustainability concerns into composite indicators (Desai, 1995; Neumayer, 2001; Costantini and Monni, 2005; Ray, 2014). Adjusted net savings or ecological footprints are used as sustainability indicators. While these indicators are, like ours, motivated by integrating sustainability concerns into measures of well-being or human development, their procedures of constructing composite indicators involve a simple geometric mean with ad hoc constant weight over countries, which has been adopted for the HDI. On the other hand, the C^2NLS method allows for a more general and flexible weighting scheme which assigns different and favourable weights to each country, like BOD.

The rest of this paper unfolds as follows. Section 2 discusses two approaches to construct a composite indicator. Section 3 explains the data of well-being indicators and sustainability. Section 4 computes composite indicators under different cases and compares them across countries. Section 5 concludes.

2. Methodology

The present study aggregates each of 36 countries' 11 well-being indicators and a single sustainability indicator into composite indicators. This is to compare countries' performance in terms of well-being, along with accounting for sustainability concerns. We adopt two approaches, namely, the BOD and C^2NLS methods, to construct composite indicators. Since they are sufficiently versatile to be applicable to a variety of problems and situations, we explain these methods below in a more general setting independent of the number of countries and underlying individual indicators.

We assume there are K countries and that the well-being of people in a country k is characterized by a set of M individual indicators, $\boldsymbol{y}_k = (y_{1,k}, \ldots, y_{M,k})'$, with $y_{m,k}$ representing the value of the m-th individual indicator of country k. Suppose that there are some sustainability indicators among M indicators, constituting $\boldsymbol{y}_k$.[6] BOD aggregates these individual indicators using their weighted average. We denote a set of weights for country k by $\boldsymbol{\mu}_k = (\mu_{1,k}, \ldots, \mu_{M,k})'$, whose component μ_{mk} represents the weight of the m-th individual indicator. The composite indicator based on BOD for country c, $CI_{BOD,c}$, is formulated as follows:

$$CI_{BOD,c} = \max_{\mu_{1,c},\ldots,\mu_{M,c}} \left\{ \Sigma_{m=1}^{M} \mu_{m,c} y_{m,c} : \Sigma_{m=1}^{M} \mu_{m,c} y_{m,k} \leq 1 \text{ for } k = 1, \ldots, K; \mu_{m,c} \geq 0 \text{ for } m = 1, \ldots, M \right\} \quad (1)$$

For the international comparison, the abovementioned procedure is repeated for every country in our sample. The weight $(\mu_{1,c}, \ldots, \mu_{M,c})$ is determined endogenously to maximize the value of the composite indicator for country c. Thus, a larger weight is assigned to an individual indicator on which the country performs well. In this procedure, a good performance of country c on an individual indicator is considered to indicate that the country prioritizes this indicator. Therefore, countries cannot excuse their poor performance by an unfair weighting scheme, because any weight other than that used for their evaluation would not improve their position. The first constraint in

[6] Sustainability indicators and well-being indicators are treated alike. Thus, we do not differentiate them in our notation.

(1) is that every country in a sample has a resulting composite indicator smaller than one when applying the most favourable weights for the evaluated country c. Thus, the resulting composite indicator for country c will be below one.

As Mahlberg and Obersteiner (2001) graphically illustrate, an alternative interpretation of $CI_{BOD,c}$ is possible. Given individual indicators $\boldsymbol{y}$ as outputs and a dummy input equal to one for all countries, $CI_{BOD,c}$ is considered as evaluating the performance of country c in terms of its productive efficiency.[7] Strictly speaking, $CI_{BOD,c}$ equals the distance between country c's well-being indicator $\boldsymbol{y}_c$ and the production frontier constructed over countries' input and output sample data by DEA. The production frontier represents the optimal practices to produce well-being. Countries whose well-being indicators $\boldsymbol{y}$ are on the frontier are considered the most efficient and are ranked the highest under BOD. The farther from the frontier and the closer to the origin the individual indicators of a country are, the lower its performance is evaluated.

One of the problems associated with BOD is that multiple countries are located on the production frontier and they are evaluated the highest. Thus, we fail to distinguish their performance. Such weak discriminatory power of the composite indicator based on BOD would be more evident in a case in which the dataset is small, which applies to the present study dealing with 36 countries. Weak discriminatory power is a well-known problem of DEA. C^2NLS has a decisive advantage over DEA and BOD by improving discriminatory power significantly.

C^2NLS is implemented in two stages. First, the production frontier is estimated by solving concave non-parametric least squares (CNLS). In the situation of a dummy input that is equal to one, the production frontier is formulated as follows:

$$\min_{\substack{\varepsilon_1,\dots,\varepsilon_K,\\ \boldsymbol{\mu}_1,\dots,\boldsymbol{\mu}_K}} \left\{ \Sigma_{i=1}^{K}\varepsilon_i^2 \,\middle|\, \begin{array}{c} \Sigma_{m=1}^{M}\mu_{m,i}y_{m,i} + \varepsilon_i = 1 \text{ and} \\ \Sigma_{m=1}^{M}\mu_{m,i}y_{m,i} \geq \Sigma_{m=1}^{M}\mu_{m,j}y_{m,i} \\ \text{for all } i,j = 1,\dots,K; \\ \mu_{m,k} \geq 0 \text{ for all } m = 1,\dots,M \text{ and all } k = 1,\dots,K \end{array} \right\} \qquad (2)$$

Let $\boldsymbol{\mu}_1^* = (\mu_{1,1}^*,\dots,\mu_{1,M}^*),\dots,\boldsymbol{\mu}_K^* = (\mu_{K,1}^*,\dots,\mu_{K,M}^*)$ be a solution to optimization problem (2). The composite indicator $CI_{BOD,c}$ is the efficiency measure for country c based on DEA.[8] The corresponding efficiency measure based on CNLS, $CI_{CNLS,c}$, is derived so that $CI_{CNLS,c} = \Sigma_{m=1}^{M}\mu_{m,c}^*y_{m,c}$ for all $c = 1,\dots,K$. Second, the efficiency measures are adjusted so that the maximum value becomes one. Then, the composite indicator based on C^2NLS for country c is defined as follows:

$$CI_{C2NLS,c} = CI_{CNLS,c} - \max_{i\in[1,\dots,K]} CI_{CNLS,i} \qquad (3)$$

We explain the characteristics of CI_{C2NLS} in comparison with CI_{BOD}. CI_{C2NLS} share flexible weighting with CI_{BOD} in the sense that every country is allowed to adopt a favourable weight.

[7] The dummy input can be considered as a helmsman in each country, which is intended to provide people with a better life. This is reflected by the values of individual well-being indicators This interpretation is rooted in Lovell et al. (1995).
[8] Formally, $CI_{BOD,c}$ is known as the output-oriented Farrell efficiency.

Optimisation problem (1) is formulated alternatively by the following equation (4),[9] which helps us to relate CI_{C2NLS} to CI_{BOD}.

$$\min_{\substack{\varepsilon_1,\dots,\varepsilon_K,\\ \boldsymbol{\mu}_1,\dots,\boldsymbol{\mu}_K}} \left\{ \sum_{i=1}^{K} \varepsilon_i^2 \;\middle|\; \begin{array}{c} \varepsilon_i \geq 0 \\ \sum_{m=1}^{M} \mu_{m,i} y_{m,i} + \varepsilon_i = 1 \text{ and} \\ \sum_{m=1}^{M} \mu_{m,i} y_{m,i} \geq \sum_{m=1}^{M} \mu_{m,j} y_{m,i} \\ \text{for all } i, j = 1, \dots, K; \\ \mu_{m,k} \geq 0 \text{ for all } m = 1, \dots, M \text{ and all } k = 1, \dots, K \end{array} \right\} \tag{4}$$

Equation (4) is simply a sign-constrained variant of the CNLS problem of equation (2). We can interpret these equations as follows: both BOD and CNLS maximize the value of each country's composite indicator by adopting its most favourable weight. While BOD faces a constraint that the resulting composite indicator is below one, CNLS is free from such a constraint. Thus, there are countries whose composite indicators become larger than one under the CNLS approach. In the case in which multiple countries are ranked the highest with the value of one for their composite indicators under the BOD, the application of the CNLS approach allows us to differentiate the performances of these countries.

3. Data

3.1. OECD Better Life Index

Amid growing concerns about identifying an alternative approach to measuring well-being, in 2011, the OECD launched the Better Life Initiative and released a set of 11 well-being indicators covering the 34 OECD member countries, comprising advanced and emerging economies. The data were updated in 2012 and more dimensions were added to calculate indicators. Moreover, the country coverage was expanded beyond the OECD to include Brazil and Russia. We use the most recent data covering individual indicators, which were released in 2014. The data are cross-sectional for a single year around 2011, as explained later in this section 3.1.

The 11 individual well-being indicators evaluate topics that the OECD considers to be essential to people's well-being. Each individual indicator corresponding to each topic is based on between one and four underlying secondary indicators, which are expressed in different units, such as dollars, years, or numbers of people. To compare and aggregate values expressed in different units, the values are normalized. This normalization is performed according to a standard formula which converts the original values of the individual indicators into numbers between 0 and 10, as follows:

$$\frac{\text{value to convert} - \text{minimum value}}{\text{maximum value} - \text{minimum value}} \times 10 \tag{5}$$

Within each topic, the secondary indicators are averaged with equal weight. For example, while the topic of the environment is constructed using two secondary indicators, *water quality* and *air pollution*, first, their scores are normalized in a range between 0 and 10. Then, they are aggregated as follows: $\frac{\text{water quality score} + \text{air pollution score}}{2}$.

[9] Endogenously determined weights $\boldsymbol{\mu}$ in equation (1) are also a solution to equation (4).

The 11 individual indicators and their corresponding 24 secondary indicators are shown below.

- 1) Income
  (Household income; Household financial wealth)
- 2) Jobs
  (Employment rate; Personal earnings; Job security; Long-term unemployment rate)
- 3) Housing
  (Rooms per person; Housing expenditure; Dwellings with basic facilities)
- 4) Work–life balance
  (Employees working very long hours; Time devoted to leisure and personal care)
- 5) Health
  (Life expectancy; Self-reported health)
- 6) Education
  (Educational attainment; Years in education; Students' skills)
- 7) Community
  (Social network)
- 8) Civic engagement
  (Consultation on rule-making; Voter turnout)
- 9) Environment
  (Water quality; Air pollution)
- 10) Safety
  (Homicide rate; Assault rate)
- 11) Life satisfaction
  (Life satisfaction)

Among the 11 individual well-being indicators, the first 3 are categorized under material living conditions and the remaining 8 are categorized as QOL. According to the dataset released by the OECD Better Life Initiative, the data years of the underlying detailed indicators range from 2008 to 2013. Averaging them with each topic equally weighted suggests a year close to 2011. Thus, we consider that the 11 indicators of each country measure the socioeconomic situation of people around 2011.

Table 1 summarizes the statistics of the 11 well-being indicators; the complete data is provided in the Appendix in Table A.1. As the OECD (2011, 2013) finds, these tables show that while life is good in many dimensions in some countries, such as Australia, Canada, Denmark, New Zealand, Norway, and Sweden, it is significantly less so in other countries, such as Chile, Mexico, Portugal, Russia, and Turkey. While the latter group of countries is characterized by lower per capita income, except for Portugal, the former group does not necessarily comprise the richest countries.

Hereafter, we group countries based on per capita GDP to consider the link between well-being and economic development, which is well reflected in per capita GDP. There are three groups, as follows: four high-income countries with per capita GDP more than USD 45,000; 13 middle-income countries with per capita GDP between USD 30,000 and 40,000; and 19 low-income countries with per capita GDP less than USD 30,000.[10] Table 1 suggests that people's well-being improves in many aspects as income grows. However, this is not always true, especially in some of the topics categorized under QOL, such as community, education, civic engagement, and work–life balance. In these respects, the average person in middle-income countries enjoys a better life than the average person in high-income countries. It is also noteworthy that the life satisfaction indicator, which has the largest standard deviation, differs significantly across countries.

3.2. The World Bank's Adjusted Net Savings Dataset

Adjusted net savings, also known as genuine savings, are designated a sustainability indicator provided by the World Bank. Its theoretical grounding is the notion that sustainability requires the maintenance of a constant stock of the 'productive base'. This is extended wealth, which is not limited to natural resources but also includes physical, produced, and intangible capital, such as human capital and the rule of law. Adjusted net savings are considered as the change in this total wealth over a given time period. As Dasgupta (2001) and Arrow et al. (2004) advocate, the productive base is the source of well-being of future generations. Thus, negative adjusted net savings indicate future generations fail to be given an opportunity set which is at least as large as that available to current generations.

The World Bank computes adjusted net savings as follows:

- Adjusted net savings = net national savings + education expenditure – natural resource depletion – carbon dioxide damage.

Net national savings is gross fixed capital formation minus the consumption of fixed capital, which indicates the amount of added produced capital. Education expenditure indicates the amount of added human capital, which makes up the larger share of intangible capital. Natural resource depletion is the sum of net forest depletion, energy depletion, and mineral depletion. Natural resource depletion with carbon dioxide damage captures the loss of natural capital. As the productive base consists of produced, natural, and intangible capital, adjusted net savings consists of changes in produced, natural, and intangible capital.

Instead of using the variable of adjusted net savings released by the World Bank, we re-compute the adjusted net savings, this time without including education expenditure, as follows:

- Adjusted net savings = net national savings – natural resource depletion – carbon dioxide damage.

There are two reasons we exclude education expenditure from the construction of the sustainability indicator in the present study. First, education expenditure is not a good measure of the changes in intangible capital.[11] Education expenditure captures changes in human capital but lacks significant parts of other intangible capital, such as the rule of law and social capital. Second, the inclusion of education expenditure leads to double counting. An increase in government expenditure on education usually improves

[10] The 4 high-income countries are Luxembourg, Norway, Switzerland, and the US; the 13 low-income countries are Brazil, Chile, Czech Republic, Estonia, Greece, Hungary, Mexico, Poland, Portugal, Russia, Slovak Republic, Slovenia, and Turkey; and the other 19 countries are middle-income countries.

[11] Moreover, the depreciation of human capital is dismissed. Thus, strictly speaking, education expenditure is a dubious measure, even for changes in human capital.

people's life conditions in terms of education. This might arise from smaller class sizes or more motivated teachers. The returns from educational investment are considered more immediate than changes in produced and natural capital. Since the *education* well-being indicator of the BLI already captures the impact of education expenditure, we exclude it from the sustainability indicator to avoid double counting. Finally, we normalize the value of adjusted net savings into the range between 0 and 10 based on equation (5) and this defines the sustainability indicator.

Table 2 summarizes the statistics of adjusted net savings and the ingredients thereof, along with the sustainability indicator. Net national savings, which indicate the net investment of produced capital, are much larger than the depletion of natural resources and carbon dioxide damage. The gap seems to be expanding as economies grow. While high-income countries seem to have larger natural resource depletion, once we exclude Norway as an exception, their average level of natural resource depletion is smaller than that of middle-income countries. Thus, the results show that as economies grow, natural resource depletion declines in general.

4. Results

We compute composite indicators based on BOD, CI_{BOD} and C^{2}NLS, CI_{C2NLS} in two cases: first, when 11 well-being indicators are aggregated, and second, when 12 indicators are aggregated (11 well-being indicators and 1 sustainability indicator). In this section, we empirically show how the change in the methodology and the inclusion of a sustainability indicator changes the score and ranking of the composite indicators.

Table 3 presents the full empirical results, containing the score and ranking of composite indicators along with existing HDI and GDP per capita. To ensure comparability with composite indicators, we rescale the HDI score so that its maximum value is 10, which is the same as the BLI. We compare the distribution of CI_{BOD}, CI_{C2NLS}, HDI, and GDP per capita among countries. According to Table 4, the mean, the variation characterized by the standard deviation, and the range of the distribution characterized by the difference between the maximum and minimum scores are roughly similar and comparable to each other for CI_{BOD}, CI_{C2NLS}, and HDI. While CI_{C2NLS} and HDI each have a similar mean, CI_{BOD} has a lower mean than these two indicators. CI_{BOD} and CI_{C2NLS} are distributed in a relatively wider range than HDI. No matter which composite indicators we adopt, their scores are shown to grow as per capita income grows. However, the difference in the score of composite indicators CI_{BOD} and CI_{C2NLS} between high-income and middle-income countries is much smaller than the difference in GDP per capita.

Table 3 shows that the lower discriminatory power of BOD becomes more evident in this study. More than 20 countries among 36 countries are assigned the highest value of one in both cases of aggregating 11 and 12 indicators. These are countries that have higher scores of HDI and GDP per capita among the sample. It is obvious that BOD fails to differentiate the performance of these countries and show its overall picture. Moving from BOD to C^{2}NLS, the comparison dramatically improves and we can completely distinguish countries' performances. Figure 1 and Figure 2 compare two composite indicators, CI_{C2NLS} and CI_{BOD}, along with the measure based on CNLS, CI_{CNLS}. Since the ratio between CI_{C2NLS} and CI_{CNLS} is constant for all countries, comparing CI_{C2NLS} and CI_{BOD} illustrates how CI_{C2NLS} improves CI_{BOD} in terms of discrimination power. It is shown that CI_{C2NLS} differentiates the performance of the countries that are ranked equally under CI_{BOD} by holding the ranking of other countries almost constant. Thus, while the international comparison of well-being based on CI_{C2NLS} is similar to that based on CI_{BOD}, CI_{C2NLS} enables us to undertake a more detailed comparison than CI_{BOD}.

Next, we consider how the inclusion of the sustainability indicator changes the composite well-being indicators by comparing the two cases. Since the present study deals with sustainability as just 1 among 12 well-being topics, the impact of the inclusion of the sustainability indicator is rather modest and it does not change the score and ranking of composite indicators dramatically. Table 3 shows that integrating the sustainability indicator raises the values of the composite indicators on average. Table 5 lists five countries whose values or rankings of their composite indicators rise the most significantly in the sample: Estonia, Israel, Korea, Russia, and Sweden. Table 5 reports the extent of the increase of both the values and the rankings of their composite indicators after sustainability concerns are included. All five countries except Sweden are relatively low income countries and have large adjusted net savings compared to their lower socioeconomic indicators. Thus, the inclusion of the sustainability indicator causes their ranking to rise. Korea significantly raises its ranking in both composite indicators, which reflects that the value of the sustainability indicator is much higher than the values of the other well-being indicators. In addition, Table 5 lists five countries whose values or rankings of their composite indicator decline the most significantly in the sample: Australia, Finland, Germany, Greece, and Japan. All are relatively high-income countries except Greece and have smaller adjusted net savings compared to their higher socioeconomic indicators. While only Australia and Finland show lower composite indicators after inclusion of the sustainability indicator, the other three countries lose their ranking under CI_{C2NLS}.

Table 6 shows the correlation of composite indicators with existing HDI and GDP per capita. It shows that all composite indicators and HDI, which share a similar pattern of distribution, are highly correlated with each other. The quest for an alternative welfare measure stems from an acknowledgement of the limitations of GDP per capita as a welfare measure. What is the extent of the difference of the ranking of countries under composite indicators from that under GDP per capita? All composite indicators are largely positively correlated with GDP per capita. Correlations are even larger in the Spearman rank correlation coefficient, which is larger than 0.7. Table 1 suggests that GDP per capita and the scores of individual well-being indicators are directly proportional in many dimensions. Larger values of individual indicators raise the composite indicators of which they are components. Therefore, the positive correlation between CI_{BOD} , CI_{C2NLS}, and GDP per capita is straightforward in the case of aggregating 11 indicators. Similarly,

Table 2 suggests that as GDP per capita grows, the sustainability indicator increases on average like the remaining 11 well-being indicators. Thus, the positive correlation between CI_{BOD}, CI_{C2NLS}, and GDP per capita is also straightforward in the case of aggregating the 12 indicators.

5. Conclusion

Well-being is a multidimensional concept. The OECD recently specified 11 topics that are essential to people's well-being and released 11 corresponding well-being indicators. However, the OECD leaves the aggregation of the data to the user and a sustainability indicator is not included among the 11 indicators. Thus, the present study introduces an additional sustainability indicator from the World Bank's adjusted net savings and aggregates the 11 well-being indicators and the sustainability indicator using composite indicators. We adopt two composite indicators based on the BOD and C^2NLS approaches. Unlike HDI, both approaches aggregate individual indicators by investigating country-specific weights that favour each country.

The composite indicator based on BOD is now a standard tool for evaluating multifaceted concepts, such as well-being. However, since more than half of countries are ranked the highest under the application of BOD in the present study, BOD fails to distinguish their performances. The composite indicator based on C^2NLS we first introduced here gives a similar cross-country ranking to that based on BOD. Moreover, it even allows us to differentiate completely the performance of countries that are ranked equally under BOD. Thus, C^2NLS enables a complete cross-country comparison of overall well-being, improving on the BOD approach.

We quantify the impact of the inclusion of the sustainability indicator into other well-being indicators by using composite indicators based on C^2NLS. The inclusion of the sustainability indicator has a rather modest effect and does not significantly change the score and ranking of composite indicators for many countries. However, the composite indicators of some countries are affected significantly by integrating the sustainability indicator. Each of these countries has a large gap between its sustainability indicator and other well-being indicators. While the composite indicators of countries whose sustainability indicator is much larger than their other well-being indicators increase their ranking, such as Korea, the composite indicators of countries whose sustainability indicator is much smaller than their other well-being indicators lose their ranking, such as Finland. Our results verify the usefulness of applying C^2NLS for integrating sustainability concerns into a composite well-being indicator.

The greater discriminatory power of the composite indicator based on C^2NLS compared with BOD does not mean that C^2NLS is a better construction method of composite indicators. Our proposal to introduce C^2NLS is justified merely from a practical standpoint. Future research should investigate the theoretical framework for evaluating composite indicators.[12]

[12] Index number theory proposes desirable axioms that plausible price indices need to satisfy (Balk, 2008). Axiomatic justification might be applicable to studies on composite indicators.

References

Arrow, K. et al., (2004). “Are We Consuming Too Much?” *Journal of Economic Perspectives*, Vol.18, No.3, pp.147–172.

Balk, B.M., (2008). *Price and Quantity Index Numbers*, New York: Cambridge University Press.

Cherchye, L. et al., (2007). “An Introduction to ‘Benefit of the Doubt’ Composite Indicators.” *Social Indicators Research*, Vol.82, No.1, pp.111–145.

Cherchye, L., Moesen, W. and Van Puyenbroeck, T., (2004). “Legitimately Diverse, yet Comparable: On Synthesizing Social Inclusion Performance in the EU.” *JCMS: Journal of Common Market Studie*, Vol.42, No.5, pp.919–955.

Costantini, V. and Monni, S., (2005). “Sustainable Human Development for European Countries.” *Journal of Human Development*, Vol.6, No.3, pp.329–351.

Dasgupta, P., (2001). *Human Well-Being and the Natural Environment*, Oxford: Oxford University Press.

Desai, M., (1995). “Greening of the HDI?” In A. McGillivray and S. Zadek, eds. *Accounting for Change*. London: The New Economics Foundation, pp. 21–36.

Despotis, D.K., (2005). “Measuring Human Development via Data Envelopment Analysis: The Case of Asia and the Pacific.” *Omega*, Vol.33, No.5, pp.385–390.

Kuosmanen, T., (2008). “Representation Theorem for Convex Nonparametric Least Squares.” *Econometrics Journal*, Vol.11, No.2, pp.308–325.

Kuosmanen, T. and Johnson, A.L., (2010). “Data Envelopment Analysis as Nonparametric Least-Squares Regression.” *Operations Research*, Vol.58, No.1, pp.149–160.

Lovell, C.A.K., Pastor, J.T. and Turner, J.A., (1995). “Measuring Macroeconomic Performance in the OECD: A Comparison of European and Non-European Countries.” *European Journal of Operational Research*, Vol.87, No.3, pp.507–518.

Mahlberg, B. and Obersteiner, M., (2001). “Remeasuring the HDI by Data Envelopement Analysis.” *IIASA interim report IR-01-069*, , No.December.

Mizobuchi, H., (2014). “Measuring World Better Life Frontier: A Composite Indicator for OECD Better Life Index.” *Social Indicators Research*, Vol.118, No.3, pp.987–1007.

Neumayer, E., (2001). “The Human Development Index and Sustainability — A Constructive Proposal.” *Ecological Economics*, Vol.39, No.1, pp.101–114.

Organisation for Economic Co-operation and Development, (2008). *Handbook on Constructing Composite Indicators: Methodology and User Guide*, Paris: OECD Publishing.

Organisation for Economic Co-peration and Development, (2011). *How’s Life?*, Paris: OECD Publishing.

Organisation for Economic Co-operation and Development, (2013). *How’s Life? 2013*, Paris: OECD Publishing.

Ray, M., (2014). “Redefining the Human Development Index to Account for Sustainability.” *Atlantic Economic Journal*, Vol.42, No.3, pp.305–316.

Stiglitz, J.E., Sen, A. and Fitoussi, J.-P., (2009). *Report by the Commission on the Measurement of Economic Performance and Social Progress*,

World Bank, (2011). *The Changing Wealth of Nations*, Washington DC: World Bank Publications.

Table 1: Descriptive Statistics, OECD Well-being Indicators

	housing	*income*	*jobs*	*community*	*education*	*environment*	*civic engagement*	*health*	*life satisfaction*	*safety*	*work-life balance*
Mean											
overall	5.6	3.5	6.7	7.6	6.5	7.2	5.2	7.0	6.2	8.3	6.7
high income	7.0	7.0	8.8	8.4	6.6	8.3	5.5	8.5	8.8	8.7	7.3
middle income	6.3	4.3	7.3	8.6	7.2	7.9	5.8	8.0	7.4	8.9	7.0
low income	4.1	1.3	5.2	5.9	5.5	5.9	4.3	5.2	3.7	7.2	6.0
Median	6.0	3.6	7.1	8.2	7.2	7.7	5.3	7.8	7.3	8.8	7.2
Std. Dev.	1.5	2.2	1.8	2.3	1.8	1.8	1.7	2.0	3.0	1.9	1.9
Max	7.8	10.0	9.6	10.0	9.2	9.8	9.5	9.4	10.0	9.9	9.8
Min	2.2	0.1	2.2	0.0	1.2	2.9	2.1	0.6	0.0	0.4	0.0

Table 2: Descriptive Statistics, World Bank Adjusted Net Savings, Constant 2011 PPP Dollars

	Sustainability index	adjusted net savings	net national savings	natural resources depletion	energy	mineral	net forest	carbon dioxide damage
Mean								
overall	4.7	1632.7 (100%)	2333.5 (143%)	614.5 (38%)	434.9	164.0	14.6	87.3 (5%)
high income	7.8	5182.8 (100%)	7096.3 (137%)	1810.6 (35%)	1770.8	30.4	2.4	109.9 (2%)
middle income	4.8	1760.3 (100%)	2182.2 (124%)	345.4 (20%)	202.3	142.0	1.8	75.7 (4%)
low income	3.5	353.9 (100%)	1089.3 (309%)	639.7 (182%)	363.9	237.1	37.0	97.3 (28%)
Median	4.3	1265.2	1599.3	101.3	46.9	12.1	0.0	75.2
Std. Dev.	2.2	2481.4	3104.3	1286.3	1184.9	483.2	34.9	44.0
Max	10.0	7750.3	14439.5	6644.1	6608.8	2285.7	140.8	207.2
Min	0.0	-3704.6	-3583.6	0.0	0.0	0.0	0.0	24.0

Table 3: Composite Indicators with HDI and GDP Per Capita

	over 12 indexes		*over 11 indexes*		*HDI*	*GDP* [a)]
	BOD	*C2NLS*	*BOD*	*C2NLS*		
Australia	10.000 (1)	9.684 (4)	10.000 (1)	9.729 (3)	9.862 (2)	41671 (10)
Austria	10.000 (1)	9.295 (18)	10.000 (1)	9.224 (18)	9.341 (20)	42888 (7)
Belgium	10.000 (1)	9.207 (22)	10.000 (1)	9.159 (22)	9.352 (19)	39840 (13)
Brazil	8.297 (34)	8.171 (34)	8.297 (33)	8.132 (34)	7.864 (36)	14301 (36)
Canada	10.000 (1)	9.660 (5)	10.000 (1)	9.637 (5)	9.564 (8)	41333 (11)
Chile	7.104 (36)	6.912 (36)	7.104 (36)	6.887 (36)	8.661 (32)	20154 (33)
Czech Republic	9.842 (22)	9.231 (20)	9.842 (22)	9.202 (19)	9.150 (25)	27047 (25)
Denmark	10.000 (1)	10.000 (1)	10.000 (1)	10.000 (1)	9.554 (10)	41831 (8)
Estonia	9.370 (28)	8.983 (29)	9.245 (29)	8.932 (29)	8.884 (27)	23310 (29)
Finland	10.000 (1)	9.586 (9)	10.000 (1)	9.592 (6)	9.341 (20)	38618 (14)
France	9.412 (27)	9.084 (26)	9.412 (26)	9.035 (25)	9.373 (17)	36264 (16)
Germany	10.000 (1)	9.435 (12)	10.000 (1)	9.427 (9)	9.649 (6)	40980 (12)
Greece	9.339 (29)	8.966 (30)	9.339 (28)	8.933 (28)	9.075 (26)	27046 (26)
Hungary	9.482 (25)	9.113 (25)	9.469 (25)	9.034 (26)	8.682 (31)	22413 (31)
Iceland	10.000 (1)	9.314 (16)	10.000 (1)	9.244 (17)	9.458 (13)	38216 (15)
Ireland	10.000 (1)	9.601 (7)	10.000 (1)	9.569 (8)	9.564 (8)	42946 (6)
Israel	9.615 (23)	9.158 (24)	9.574 (24)	9.075 (24)	9.405 (16)	30159 (23)
Italy	9.211 (30)	8.836 (31)	9.211 (30)	8.805 (31)	9.267 (23)	34626 (18)
Japan	10.000 (1)	9.302 (17)	10.000 (1)	9.282 (15)	9.426 (14)	34316 (19)
Korea	10.000 (1)	9.589 (8)	9.860 (21)	9.386 (12)	9.416 (15)	31327 (22)
Luxembourg	10.000 (1)	9.217 (21)	10.000 (1)	9.166 (21)	9.362 (18)	88848 (1)
Mexico	9.113 (31)	8.994 (28)	9.113 (31)	8.930 (30)	7.991 (34)	15887 (35)
Netherlands	10.000 (1)	9.449 (11)	10.000 (1)	9.424 (10)	9.713 (3)	43148 (5)
New Zealand	10.000 (1)	9.369 (14)	10.000 (1)	9.315 (14)	9.607 (7)	31712 (21)
Norway	10.000 (1)	9.937 (2)	10.000 (1)	9.876 (2)	10.000 (1)	61896 (2)
Poland	10.000 (1)	9.411 (13)	10.000 (1)	9.372 (13)	8.820 (28)	21748 (32)
Portugal	8.776 (32)	8.588 (32)	8.776 (32)	8.544 (32)	8.704 (30)	25828 (27)
Russian Federation	8.302 (33)	8.289 (33)	8.249 (34)	8.164 (33)	8.236 (33)	22570 (30)
Slovak Republic	9.582 (24)	9.199 (23)	9.582 (23)	9.151 (23)	8.789 (29)	25128 (28)
Slovenia	9.420 (26)	9.016 (27)	9.378 (27)	8.953 (27)	9.288 (22)	28156 (24)
Spain	10.000 (1)	9.321 (15)	10.000 (1)	9.273 (16)	9.224 (24)	31732 (20)
Sweden	10.000 (1)	9.506 (10)	10.000 (1)	9.408 (11)	9.522 (11)	41763 (9)
Switzerland	10.000 (1)	9.721 (3)	10.000 (1)	9.674 (4)	9.713 (3)	51302 (3)
Turkey	8.087 (35)	7.758 (35)	8.012 (35)	7.711 (35)	7.991 (34)	17998 (34)
United Kingdom	10.000 (1)	9.643 (6)	10.000 (1)	9.583 (7)	9.469 (12)	34800 (17)
United States	10.000 (1)	9.246 (19)	10.000 (1)	9.196 (20)	9.681 (5)	49855 (4)

a) Unit: Constant 2011 PPP US dollar
Note: Parentheses indicate country ranking

Table 4: Descriptive Statistics of Composite Indicators

	over 12 indexes		over 11 indexes		HDI	GDP [a)]
	BOD	C2NLS	BOD	C2NLS		
Mean						
overall	9.5820	9.1608	9.5684	9.1118	9.1944	35046
high income	10.0000	9.5302	10.0000	9.4781	9.6892	62975
middle income	9.9073	9.4230	9.8978	9.3772	9.4793	37798
low income	8.9780	8.6638	8.9543	8.6112	8.6258	22430
Median	10.0000	9.2704	10.0000	9.2129	9.3571	34471
Std. Dev.	0.6882	0.6035	0.6955	0.6072	0.5339	14046
Max	10.0000	10.0000	10.0000	10.0000	10.0000	88848
Min	7.1041	6.9122	7.1041	6.8872	7.8640	14301

a) Unit: Constant 2011 PPP US dollar

Table 5: Difference in Value and Ranking of Composite Indicators

	BOD		C2NLS		Sustainability indicator		Average of 11 indicators	
	value	ranking	value	ranking				
Countries certainly increasing composite indicators								
Estonia	0.1254	1	0.0504	0	4.45	(11)	5.3	(28)
Israel	0.0408	1	0.0824	0	5.09	(9)	5.9	(24)
Korea	0.1402	20	0.2033	4	7.04	(3)	5.7	(25)
Russian Federation	0.0532	1	0.1246	0	4.16	(10)	4.3	(33)
Sweden	0.0000	0	0.0981	1	7.54	(5)	8.0	(2)
Countries cerainly decreasing composite indicators								
Australia	0.0000	0	-0.0454	-1	3.94	(23)	8.1	(1)
Finland	0.0000	0	-0.0066	-3	4.47	(20)	7.6	(8)
Germany	0.0000	0	0.0079	-3	5.94	(7)	7.3	(14)
Greece	0.0000	-1	0.0327	-2	0.00	(36)	4.2	(34)
Japan	0.0000	0	0.0200	-2	2.81	(30)	6.3	(21)

Note: Parentheses indicate country ranking

Table 6: Correlation among Composite Indicators

	over 12 indexes		over 11 indexes		HDI	GDP
	BOD	C2NLS	BOD	C2NLS		
	Correlation coefficient					
Aggregation over 12 indexes						
BOD	1.0000	0.9518	0.9988	0.9496	0.7639	0.5635
C2NSL	0.9518	1.0000	0.9501	0.9978	0.7353	0.5220
Aggregation over 11 indexes						
BOD	0.9988	0.9501	1.0000	0.9498	0.7670	0.5711
C2NSL	0.9496	0.9978	0.9498	1.0000	0.7423	0.5265
HDI	0.7639	0.7353	0.7670	0.7423	1.0000	0.6963
GDP	0.5635	0.5220	0.5711	0.5265	0.6963	1.0000
	Spearman rank correlation coefficient					
Aggregation over 12 indexes						
BOD	1.0000	0.8868	0.9823	0.8842	0.7910	0.7672
C2NSL	0.8868	1.0000	0.8630	0.9925	0.8169	0.7109
Aggregation over 11 indexes						
BOD	0.9823	0.8630	1.0000	0.8731	0.7844	0.7844
C2NSL	0.8842	0.9925	0.8731	1.0000	0.8247	0.7210
HDI	0.7910	0.8169	0.7844	0.8247	1.0000	0.8572
GDP	0.7672	0.7109	0.7844	0.7210	0.8572	1.0000

Table 7: Average Weight for Composite Indicators

	housing	*income*	*jobs*	*community*	*education*	*environment*	*civic engagement*	*health*	*life satisfaction*	*safety*	*work-life balance*	*sustainability*
Aggregation over 12 indexes												
BOD	0.0937	0.1186	0.0227	0.0634	0.0955	0.0537	0.0427	0.1204	0.0497	0.2480	0.1744	0.0982
C2NSL	0.0296	0.0456	0.0307	0.1266	0.0399	0.0306	0.0586	0.0389	0.2593	0.2346	0.1802	0.0216
Aggregation over 11 indexes												
BOD	0.0587	0.1130	0.0704	0.0812	0.1011	0.0806	0.0204	0.1062	0.0497	0.2891	0.1904	
C2NSL	0.0226	0.0460	0.0447	0.0842	0.0417	0.0486	0.0537	0.0391	0.2235	0.2339	0.2466	

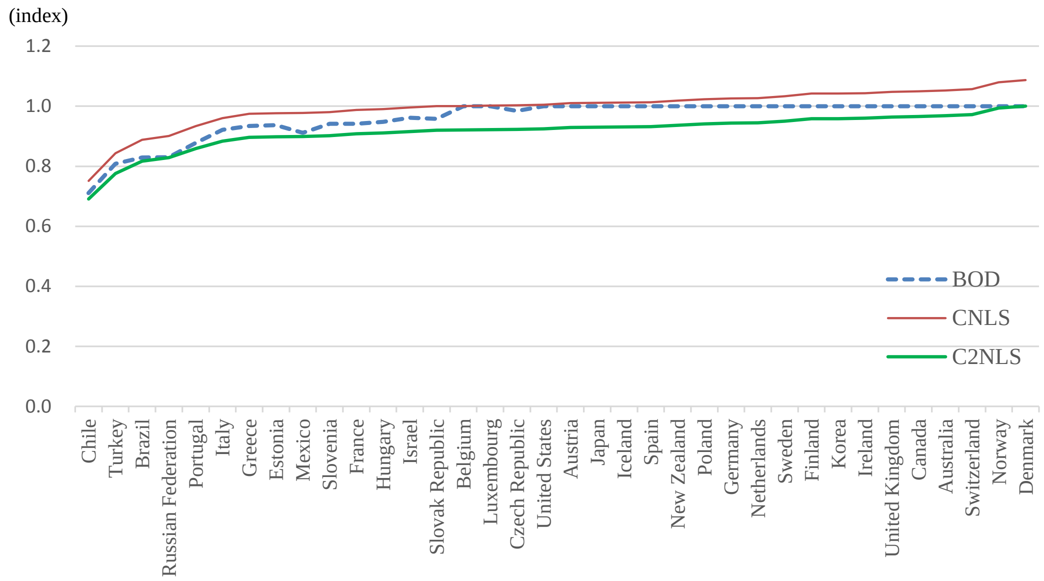

Figure 1: Comparison of Composite Indicators Based on BOD and C^{2}NLS (12 indices)

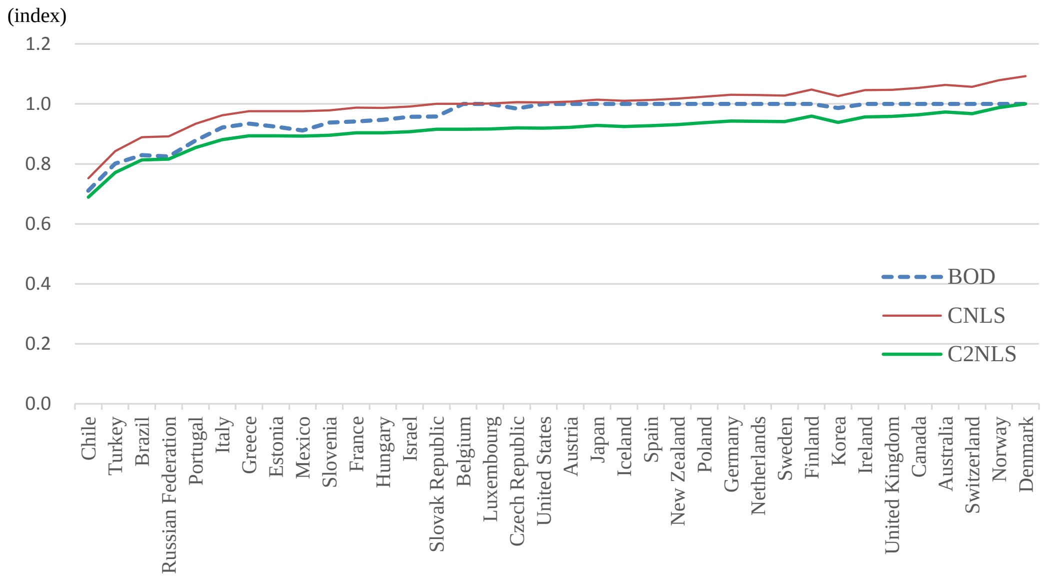

Figure 2: Comparison of Composite Indicators Based on BOD and C^{2}NLS (11 indices)

Table A.1: Well-being Indicators and Sustainability Indicator

	housing	*income*	*jobs*	*community*	*education*	*environment*	*civic engagement*	*health*	*life satisfaction*	*safety*	*work-life balance*	*sustainability*
Australia	7.6 (4)	4.9 (12)	8.5 (6)	8.9 (10)	7.8 (8)	9.1 (2)	9.5 (1)	9.4 (1)	8.7 (11)	9.6 (5)	5.3 (29)	3.94 (23)
Austria	5.8 (21)	5.0 (9)	8.6 (5)	9.7 (5)	6.7 (21)	7.3 (20)	5.6 (15)	7.7 (19)	9.1 (5)	9.1 (12)	5.9 (26)	6.14 (8)
Belgium	7.3 (5)	5.9 (4)	7.3 (18)	8.1 (19)	7.5 (14)	7.2 (22)	5.8 (13)	7.8 (17)	7.8 (15)	7.5 (30)	8.8 (3)	4.92 (13)
Brazil	4.2 (27)	0.1 (36)	5.7 (27)	7.8 (22)	1.9 (35)	6.0 (27)	4.4 (24)	4.9 (33)	8.1 (13)	2.1 (35)	6.7 (21)	2.54 (31)
Canada	7.8 (1)	5.7 (5)	8.0 (9)	9.2 (7)	7.7 (12)	8.6 (10)	5.8 (13)	9.3 (3)	9.4 (3)	9.7 (4)	6.2 (25)	4.37 (17)
Chile	3.7 (32)	1.1 (32)	5.8 (26)	6.1 (31)	4.4 (32)	3.3 (35)	4.3 (25)	5.8 (25)	6.1 (23)	6.7 (33)	5.1 (32)	1.34 (34)
Czech Republic	4.6 (25)	1.8 (27)	6.3 (23)	6.7 (29)	7.8 (8)	7.5 (19)	3.7 (30)	5.8 (25)	6.5 (21)	9.3 (8)	7.2 (16)	2.97 (27)
Denmark	6.2 (16)	4.0 (15)	8.0 (9)	10.0 (1)	7.8 (8)	9.0 (3)	7.1 (5)	7.4 (21)	9.4 (3)	8.8 (16)	9.8 (1)	5.91 (12)
Estonia	4.4 (26)	0.9 (33)	5.6 (28)	7.4 (25)	8.1 (3)	8.4 (11)	2.3 (34)	4.5 (34)	2.1 (32)	7.3 (32)	7.4 (14)	4.45 (11)
Finland	6.3 (12)	3.5 (19)	7.5 (16)	9.0 (9)	9.2 (1)	9.0 (3)	5.9 (12)	7.5 (20)	8.9 (7)	9.3 (8)	7.4 (14)	4.47 (20)
France	6.4 (11)	5.0 (9)	6.5 (21)	8.2 (17)	5.9 (27)	8.4 (11)	4.3 (25)	7.9 (16)	6.4 (22)	8.3 (24)	7.6 (12)	4.34 (14)
Germany	6.3 (12)	5.3 (7)	8.3 (7)	8.9 (10)	8.0 (4)	8.8 (8)	3.9 (27)	7.2 (22)	7.3 (18)	8.9 (14)	7.9 (7)	5.94 (7)
Greece	3.8 (30)	1.9 (26)	2.2 (36)	0.0 (36)	6.1 (25)	4.6 (32)	3.9 (27)	8.2 (13)	0.0 (36)	8.8 (16)	7.2 (16)	0.00 (36)
Hungary	3.8 (30)	1.3 (29)	4.8 (31)	6.9 (28)	6.7 (21)	7.3 (20)	4.8 (22)	4.3 (35)	0.6 (34)	8.8 (16)	7.8 (11)	3.66 (15)
Iceland	5.9 (19)	3.6 (18)	8.7 (3)	10.0 (1)	7.3 (16)	8.8 (8)	5.3 (16)	8.8 (6)	9.1 (5)	9.2 (11)	5.7 (27)	1.95 (35)
Ireland	7.3 (5)	3.3 (20)	5.9 (25)	9.9 (4)	7.1 (19)	8.3 (13)	6.0 (11)	8.7 (8)	6.7 (20)	9.4 (7)	7.9 (7)	4.57 (18)
Israel	4.2 (27)	3.8 (17)	6.7 (20)	7.7 (23)	5.4 (28)	5.4 (29)	2.3 (34)	9.0 (5)	7.8 (15)	7.4 (31)	4.9 (33)	5.09 (9)
Italy	5.1 (23)	4.4 (14)	5.6 (28)	8.4 (16)	5.1 (30)	6.8 (26)	4.5 (23)	7.8 (17)	4.2 (25)	8.4 (23)	7.5 (13)	2.72 (32)
Japan	4.9 (24)	5.6 (6)	7.9 (11)	7.9 (21)	7.9 (7)	6.9 (24)	3.9 (27)	5.0 (30)	4.1 (27)	9.9 (1)	5.2 (31)	2.81 (30)
Korea	5.9 (19)	2.3 (23)	7.6 (14)	3.1 (34)	8.0 (4)	5.3 (30)	7.5 (3)	5.0 (30)	4.2 (25)	9.5 (6)	4.2 (34)	7.04 (3)
Luxembourg	6.2 (16)	6.5 (3)	8.3 (7)	7.3 (26)	4.5 (31)	8.0 (16)	6.8 (7)	8.0 (15)	7.9 (14)	8.3 (24)	7.9 (7)	7.22 (4)
Mexico	3.7 (32)	0.7 (34)	6.0 (24)	2.0 (35)	1.2 (36)	4.5 (33)	5.3 (16)	5.0 (30)	8.9 (7)	0.4 (36)	2.6 (35)	3.01 (24)
Netherlands	6.9 (7)	5.3 (7)	8.7 (3)	8.6 (15)	7.8 (8)	6.9 (24)	5.0 (20)	8.3 (12)	8.8 (10)	8.3 (24)	8.8 (3)	6.59 (6)
New Zealand	6.6 (9)	2.1 (25)	7.5 (16)	10.0 (1)	7.3 (16)	9.0 (3)	7.2 (4)	9.4 (1)	8.4 (12)	9.3 (8)	6.3 (23)	3.81 (26)
Norway	7.7 (3)	4.0 (15)	9.2 (2)	8.9 (10)	7.3 (16)	8.9 (7)	6.5 (8)	8.1 (14)	9.7 (2)	8.8 (16)	8.7 (5)	10.00 (1)
Poland	3.5 (34)	1.3 (29)	5.2 (30)	7.7 (23)	8.5 (2)	4.8 (31)	5.3 (16)	5.2 (28)	3.4 (30)	9.8 (2)	5.6 (28)	3.49 (21)
Portugal	6.6 (9)	2.5 (22)	4.5 (32)	6.2 (30)	4.4 (32)	7.8 (18)	3.3 (33)	5.9 (24)	1.4 (33)	8.0 (28)	6.8 (20)	1.83 (33)
Russian Federation	3.3 (35)	1.2 (31)	6.8 (19)	5.8 (32)	6.1 (25)	4.3 (34)	2.1 (36)	0.6 (36)	2.7 (31)	6.5 (34)	7.9 (7)	4.16 (10)
Slovak Republic	4.1 (29)	1.4 (28)	4.5 (32)	7.3 (26)	6.2 (24)	8.1 (15)	3.6 (31)	5.4 (27)	4.0 (29)	9.1 (12)	7.2 (16)	3.00 (25)
Slovenia	5.8 (21)	2.2 (24)	6.5 (21)	8.8 (13)	7.6 (13)	7.1 (23)	6.2 (9)	6.6 (23)	4.1 (27)	8.8 (16)	6.6 (22)	3.87 (19)
Spain	6.8 (8)	2.9 (21)	2.6 (35)	8.7 (14)	5.4 (28)	6.0 (27)	5.0 (20)	8.7 (8)	4.7 (24)	8.7 (21)	9.4 (2)	3.15 (28)
Sweden	6.3 (12)	5.0 (9)	7.8 (13)	8.2 (17)	8.0 (4)	9.8 (1)	8.7 (2)	8.8 (6)	8.9 (7)	8.2 (27)	8.1 (6)	7.54 (5)
Switzerland	6.3 (12)	7.3 (2)	9.6 (1)	9.5 (6)	7.4 (15)	8.3 (13)	3.4 (32)	9.3 (3)	10.0 (1)	8.7 (21)	7.1 (19)	8.07 (2)
Turkey	2.2 (36)	0.6 (35)	4.3 (34)	3.8 (33)	2.5 (34)	2.9 (36)	6.2 (9)	5.2 (28)	0.5 (35)	7.8 (29)	0.0 (36)	3.25 (16)
United Kingdom	6.0 (18)	4.8 (13)	7.6 (14)	9.2 (7)	6.4 (23)	9.0 (3)	6.9 (6)	8.4 (11)	7.2 (19)	9.8 (2)	6.3 (23)	3.53 (29)
United States	7.8 (1)	10.0 (1)	7.9 (11)	8.0 (20)	7.1 (19)	7.9 (17)	5.3 (16)	8.5 (10)	7.5 (17)	8.9 (14)	5.3 (29)	4.41 (22)

Note: Parentheses indicate country ranking