UNIVERSIDADE CATÓLICA PORTUGUESA

An objective approach on well-being:

Case of OECD countries

Daniel Brochado da Cunha

Católica Porto Business School

July 2022

UNIVERSIDADE CATÓLICA PORTUGUESA

An objective approach on well-being: Case of OECD countries

Trabalho Final na modalidade de Dissertação

apresentado à Universidade Católica Portuguesa

para obtenção do grau de mestre em Gestão (especialidade em Business Analytics)

por

Daniel Brochado da Cunha

sob orientação de

(Assoc. Professor Dr.) Conceição A. Silva

Católica Porto Business School

July 2022

Acknowledgements

I would like to start by sincerely thanking my supervisor Prof. Maria Conceição A. Silva for supporting me throughout this journey. Her guidance was crucial for the development of this thesis, which was manifested by constant support and patience. Her wisdom and brilliant capacity to pass on knowledge helped me tremendously in the elaboration of the different phases of this manuscript.

Very special thanks to my girlfriend which always supported me emotionally and always encouraged me to reach my goals. This would not be possible without her unconditional support.

Finally, I would like to thank my family who always supported me, for which I am extremely grateful.

List of abbreviations

BLI: Better Life Index

BOD: Benefit of the Doubt

CCR: Chames, Cooper and Rhodes

CRS: Constant Returns to Scale

DEA: Data Envelopment Analysis

DMU: Decision-making Unit

EMS: Efficiency Measurement System

GDP: Gross Domestic Product

GNHI: Gross National Happiness Index

MOP: Multiple Objective Programming

OECD: Organization for Economic Cooperation and Development

RTS: Returns to Scale

SWB: Subjective Well-being

TFP: Total Factor Productivity

VRS: Variable Return to Scale

Resumo

O bem-estar é um conceito multidimensional que depende de fatores como condições financeiras, saúde, educação, entre outras. Esta tese desenvolve uma perspetiva objetiva sobre o bem-estar, tendo como finalidade criar um indicador compósito baseado em variáveis objetivas, que facilitem a comparação dos diferentes níveis de bem-estar entre países e ao longo do tempo. De facto, os países da OCDE irão ser avaliados com base nos seus níveis de bem-estar, tendo em consideração a sua evolução entre 2018 e 2020. Além disso, iremos avaliar como as idiossincrasias dos países contribuem para maiores níveis de bem-estar. Esta tese aborda também a análise de indicadores subjetivos como o Better Life Index (BLI), criado pela OCDE, que contém algumas limitações em relação à comparação dos países ao longo do tempo. O objetivo final consiste em comparar a perspetiva objetiva de bem-estar com indicadores subjetivos tais como o BLI, enquanto avaliamos os resultados de cada abordagem.

A utilização do DEA permitiu-nos uma avaliação mais precisa e objetiva, onde cada país foi capaz de otimizar o seu nível de bem-estar com base nas características nas quais são relativamente melhores, enquanto são comparados com os países que obtiveram melhor desempenho. Dois cenários foram considerados na elaboração dos modelos DEA, sendo que o primeiro permite que os pesos dos indicadores assumam o valor que maximiza a performance desse país, enquanto que o segundo considera restrições nos pesos das variáveis. Verificamos que os resultados do indicador objetivo do bem-estar estão fortemente correlacionados com as perspetivas mais subjetivas.

Palavras-chave: Data Envelopment Analysis, Bem-estar, Felicidade, Regressão Linear

Número de Palavras: 9505

Abstract

Well-being is a multidimensional concept that depends on factors such as financial conditions, health, education, and so on. This thesis develops an objective approach to well-being, aiming to create a composite indicator based on objective variables, which facilitates the comparison of well-being levels between countries and throughout time. In fact, OECD countries will be evaluated on their well-being levels, while observing their evolution between 2018 and 2020. In addition, we will assess how the idiosyncrasies of the countries contribute to higher well-being levels. Besides that, this manuscript contains the analysis of more subjective well-being indexes such as the Better Life Index (BLI), created by the OECD, which contain some limitations regarding the comparison of countries throughout time. The final goal relies on comparing the objective approach on well-being to well-known subjective indexes such as BLI, while evaluating the results of each approach.

The use of DEA allowed for a more accurate and objective evaluation, where each country was able to optimize its well-being score based on traits in which they performed relatively better, while being benchmarked against the best performing countries. Two DEA scenarios were considered, the first consisting in allowing weights of the indicators to assume the value that maximizes the performance of the country, while the second considered restrictions to the variables' weights. Our findings illustrate that the results of the objective well-being index are highly correlated with more subjective approaches.

Keywords: Data Envelopment Analysis, Well-being, Happiness, Linear Regression Analysis

Number of Words: 9505

Table of Contents

Tables Index

Figures Index

1. Introduction

There is a growing concern in society about well-being and happiness of the individual. In fact, there is a rise of studies in the literature regarding the topic at the micro level, i.e., how the well-being of the employees affects the performance of the company. However, there is a lack of macro level studies regarding the comparison of countries in well-being levels and how their characteristics impact and favor those results.

The overarching goal of this thesis is to contribute to the discussion of well-being at the macro level by constructing an objective composite index of objective variables and, subsequently, evaluating the well-being scores of a sample of OECD countries between 2018 and 2020, as well as identifying how their idiosyncrasies favor their well-being levels.

The thesis will start with an analysis of relevant literature, which will be discussed in a concise way. Once the contribution of the authors is referred, the method that this study relies on will be detailed and explained. Section 4 includes the description of the variables that will be used in the construction of the composite index, as well as a descriptive analysis on the data. An aggregate index will be constructed in section 5 and, subsequently, the OECD countries will be assessed based on their well-being scores. Lastly, in section 6 will be displayed the conclusion of this thesis, with its key findings.

2. Literature's Review

2.1. The concept of happiness

The ancient Greek were preoccupied with matters such as the purpose of human existence. Moreover, there was an introspection mindset in order to attempt to grasp the goal for which human beings should direct all their activities. According to Aristotle, that goal should be self-sufficient, and it should be desirable in itself and not for the sake of something else. According to the Greek philosopher, happiness is that goal and the end that checks all those requirements (Aristotle, 2009)

Since those ancient times, individuals became less introspective, especially regarding matters such as happiness and well-being. Only since recently, more specifically in the 1950s, this topic emerged from the ashes and has been studied at a faster momentum. Until this time, psychologist were primarily concerned with negative emotions, such as depression and those that trigger suicidal thoughts (van Hoorn, 2008). In fact, Wilson (1967) concluded that seldom advancements were made, regarding understanding the complex topic of happiness, since the ancient time of the Greek philosophers. In addition, the latter author performed a review, where he analyzed papers regarding happiness and the respective psychological traits of the people. In fact, he collected data on happiness regarding correlations, measurements, validity and reliability. The author concluded that "the happy person emerges as a young, healthy, well-educated, well-paid, extroverted, optimistic, worry-free, religious, married person with high self-esteem, high job morale, modest aspirations, of either sex and of a wide range of intelligence". In this manner, in earlier times, philosophers believed that happiness was related to a one-size fits all checklist, in which for an individual to be happy, he must obey to the society's standard of success.

However, in more recent years, there was a realization that there isn't a one-size-fits-all "formula" for happiness. In fact, there are extremely successful people in various aspects of life, i.e., people that fit the "formula", that are unhappy. On the other hand, there are people that society doesn't view as successes but are quite happy. This means that the, so called "formula" started to weaken, so happiness is more idiosyncratic than systematic. For example, a highly demanding, time-consuming, job can motivate and bring happiness to certain people, while others would prefer to have a repetitive 9 to 5 job and have more time for leisure.

2.2. The concept of Subjective Well-being

Therefore, throughout the years, authors and psychologists became more interested in what is called subjective well-being (which is normally abbreviated as SWB) (van Hoorn, 2008). According to Diener et al. (1999) "Subjective well-being is a broad category of phenomena that includes people's emotional responses, domain satisfaction, and global judgements of life satisfaction". In fact, well-being is not a size-fits-all remedy, that is why it is subjective, i.e., it depends on the expectations and experience of an individual. subjective well-being implies not only the absenteeism of negative emotions, but also the presence of positive emotions. Lastly, the definition of subjective well-being implies that an individual's life must be assessed in a broad sense, rather than in a specific area of his life (Ed Diener, 1994).

2.2.1. Main views on Subjective Well-being

According to Kim-Prieto et al (2005), happiness is one of the many components of subjective well-being. Other components are comprised by life satisfaction,

fulfillment and the most important aspect, the appraisal of one's life at the cognitive level. Furthermore, the authors state that there are three main views of subjective well-being, the first being the appraisal of one's life and its components at a macro level, i.e., a global assessment of life. In fact, this approach does not take into account the small moments that bring joy to an individual. For example, this approach does not consider the instant gratification of a dream vacation, a promotion at work, and so on. One example of measuring this approach on subjective well-being is a survey that asks how an individual ranks the facets of life, such as human interconnection, job satisfaction, and so on. One can argue that this is the most superficial approach. The second approach takes into account the chronological aspect. In fact, this view assesses an individual's life by asking how he felt in a specific time frame. One example is asking how a person felt in the past week or month, or for example, assessing the chronological stages of an individual's life, such as childhood, adulthood, and so on. Thus, for measuring this second approach, instead of asking an individual how satisfied he feels, regards past memories of one's life on an emotional level. Lastly, the third approach of subjective well-being considers satisfaction in a continuous stretch of time. For this latter view, there is a continuous assessment of one's emotions in order to, subsequently, gather an average level of the individual's emotional state.

2.3. The concept of Productivity

Productivity is a very important and recurrent term in economics. Productivity is, in its essence, the ratio between output per unit of the input utilized. The input can consist in labor, capital, or any other available resource. Greater productivity can be achieved by increasing output while maintaining the same level of input. In addition, if one utilizes less input and achieves the same output, it also translates in more productivity. On the other hand, productivity declines when one achieves less output

for the same level of input, or when one achieves the same level of output while requiring more input. Productivity is widely used since it is very versatile, i.e., it can be used, for instance, for measuring the efficiency in a given company (e.g., output per hour worked) or even measuring the efficiency of a country (e.g., gross domestic product per capita). Moreover, productivity can be used for measuring the efficiency of a person. For example, a writer can assess how productive he was by dividing the number of sentences written by the hours he took to write them. The result will be the number of sentences written per hour.

There are two widely utilized concepts of productivity, labor productivity and total factor productivity (TFP). The former consists, for the economy as a whole, in dividing the economy's gross domestic product (GDP) by the total labor hours that it took to produce that GDP. Total Factor Productivity (TFP) consists in the ratio between the output and all of the inputs taken together. In this manner, the level of Total Factor Productivity is determined by how efficiently and intensely the inputs are utilized in production (Comin, 2006).

Productivity is considered a crucial source of the competitiveness of a country and its economic growth and, as a consequence, it is recurrently utilized in statistical comparisons between countries (Krugman, 1994).

2.4. The relationship between productivity and happiness

Recently, there has been a growing concern in the literature for including psychological aspects into economic science (Piekałkiewicz, 2017). In fact, there are authors that treat happiness as a dependent variable, assessing, for instance, if individual income determines the level of happiness. On the other hand, there are authors that treat happiness as an explanatory variable, i.e., independent variable, who attempt to understand, for example, if happiness increases productivity in workers.

Additionally, there are two main perspectives that are adopted in the literature, the macro and the micro, in which the first regards comparisons between countries and the latter compares the relationship between happiness and productivity at the company level.

2.4.1. Studies at the micro level

Regarding the micro perspective, it was argued, several years ago, that the happiness of the workers was not related to greater productivity (Brayfield & Crockett, 1955).

Nonetheless, more recent studies started to disagree with that statement. One example is Wright & Staw (1999), which conducted two longitudinal studies, where staff employed by the public sector recorded their affective state, i.e., their mood, and their affective disposition, i.e., their mental health, in order to see correlations with productivity. Note that affective state is a state of being in the short-term, while affective disposition is related to long-term. The authors' results showed that positive mood was more correlated with good performance than negative mood, but few correlations had statistical significance. This means that a worker is more productive when he is in a better mood. However, the correlation was not very strong, so the premise is not well sustained by this study. Additionally, these results were not definitive since the authors had issues with assessing short-term positive impacts in affective state, since it implies that the productivity of the employees must be assessed right after the positive impacts. However, the results showed that affective disposition was a stronger predictor of rated performance, which makes sense since it is a long-term effect. This means that mental health is a better indicator for predicting the performance of a given worker, rather than his mood, since mood is a more volatile indicator, i.e., it fluctuates greatly throughout time, while mental health is a more stable indicator. Thus, these authors state that there is no strong evidence that

organizational conditions improve performance, rather the state of mind of the employee in the long-term.

On the other hand, Oswald et al. (2015) conducted a series of experimental studies, where random subjects are exposed to different events that make them prone to be happy, such as showing them comedy clips or giving free food such as chocolate. The objective of these experiments was to document if "happiness shocks" increased the productivity of the individuals. In fact, before and after the shocks, the individuals performed some mathematical tasks, in order to understand the evolution of their performance, i.e., assessing the number of correct answers in the quizzes. What these authors concluded is that the subjects that received positive (happy) shocks were the ones that increased the productivity the most (in approximately 12%). Furthermore, the authors studied the impact of major life tragedies in productivity and concluded that these events were correlated with lower productivity. Therefore, contrary to Wright & Staw (1999), these authors argue that short-term shocks improve the performance of employees.

2.4.2. Studies at macro level

The abovementioned articles approach the topic at micro level, i.e., at the company level. The topic is very recent in the literature, specially at the macro level. Therefore, there are few articles regarding this point of view.

For instance, the notorious "Easterlin Paradox" states that, over the long term, i.e., more than ten years, happiness and a country's income are not directly correlated (Easterlin et al., 2010). This means that when a country's income increases, happiness levels tend to stay the same. However, in the short-term, there is a positive relationship between economic growth and happiness. In fact, the mentioned study was applied originally to United States of America, but with time, it was broadened to seventeen

developed countries, scattered around Europe and Asia, and nine non-developed countries, located in Latin America, Asia and Africa. The author uses life satisfaction and financial satisfaction as measures of happiness. The author assessed this relationship in developed and developing countries separately, as well as with three groups together, i.e., developing countries, developed countries and transition countries, with the results remaining the same. The results for this study show that, through a time-series analysis, i.e., comparing the same countries over time (long-term), economic growth and subjective well-being is not correlated. However, the paradox exists because, according to the author, in the short term, there is a relationship between subjective well-being and economic growth. In fact, when taking into account a cross-section analysis, i.e., analyzing a group of countries in a specific timeframe (short-term), according to the author, there is evidence for a positive correlation between happiness and economic growth. For instance, when a country expands or collapses financially, the financial satisfaction of the people increases or decreases, respectively. However, if the whole period of expansion and collapse is taken into account, the long-term effect is null. This means that, in the short term, if a country's economic growth increases, individuals' well-being will increase. However, in the long-term, that well-being will stabilize since people will get used to those economic conditions. The author assessed this by fitting OLS regression lines and computing the deviation at each date, while comparing with the trend value.

There are authors such as DiMaria et al. (2020) that attempt to match data sets and try to find a relationship between well-being and productivity at the aggregate level. In fact, the abovementioned authors utilize data envelopment analysis (DEA), benchmarking OECD countries against the best performing ones. The results show that when subjective well-being is an input to production, the productivity increases. Note that the authors utilize total factor productivity, which takes into account labor and capital.

(Koronakos et al., 2020) use the OECD better-life index and introduces a bottom-up procedure to aggregate the components at each level. In fact, the better-life index's hierarchical structure, according to the authors, is divided in three levels. For instance, years in education is part of the first level, which later will be integrated in the second level, i.e., education. Furthermore, all of the first and second level elements will be aggregated in the third and last level, which is the composite index. In addition, the authors used public opinion about well-being so that there are weight restrictions in the elements. The assessment of the Better-life Index was formulated as a multiple objective programming (MOP) problem where the performance of each country was treated as a distinct objective criterion. The results showed that public opinion, for purposes of weight restrictions, can effectively drive the optimization process and portray the collective preferences to the Better-Life Index scores.

Lastly, Ortiz-Ospina & Roser (2017) performed a macro comparison between countries, regarding the relation between self-reported life satisfaction and GDP per capita. In fact, a positive correlation is evident between these two variables, which means that the richest countries tend to be the ones that report more life satisfaction. Since productivity is greatly related to GDP per capita (Korkmaz & Korkmaz, 2017), as a consequence, the countries that have higher values of GDP per capita are the ones that tend to have higher levels of productivity. Therefore, the countries which are more productive tend to report more life satisfaction. This means that people in these countries - richer countries- are happier and, therefore, more productive.

2.5. Measurement and indexes of happiness and well-being

Since a long time ago, governments and policymakers have been using GDP for assessing economic growth, as well as well-being. However, Ed Diener et al. (2013) concluded in their study that, although GDP per capita is related to subjective well-

being, predicting life evaluations overtime, it is not sufficient by itself, since GDP per capita can not necessarily translate to household income if that increase goes to the richer or to inefficient governments. Therefore, other factors relevant for subjective well-being correspond to health, education, personal relationships, and so on (Ovaska & Takashima, 2006).

2.5.1. Better Life Index (BLI)

The Organization for Economic Co-operation and Development (OECD) created a **Better Life Index (BLI)**, with the intent of further understand what drives the well-being of people. The index takes into account several socio-demographic aspects, such as housing, income, jobs, community, education, and so on (as evidenced in the figure below). Additionally, it considers a subjective variable named life satisfaction, which consists in a poll where people evaluate their life as a whole from a scale ranging from 0 to 10. An individual can attribute weights to each of the dimensions referred above, and the index will compare the countries based on the given weights. For instance, if one individual greatly values education, the output will likely be a Nordic country, such as Finland.

However, the index has some limitations since the comparisons cannot be made over time. Furthermore, for the indicators used there is a lack of data for several countries, which results in an inconsistent comparison.

2.5.2. Gross National Happiness Index (GNHI)

The Kingdom of Bhutan developed the Gross National Happiness Index (GNHI), which takes into account nine domains: psychological well-being, health, education, time balance, cultural diversity and resilience, good governance,

community vitality, ecological diversity and resilience, and living standards (Ura et al., 2012). This indicator takes a global perspective on well-being, not solely focused on economic factors. With this index, the Bhutanese policymakers attempt to avoid implementing policies that solely focus on economic development in detriment of key factors of people's well-being.

2.5.3. Happiness Index – Developed by Happiness Alliance

Based on GNHI of Kingdom of Bhutan, Happiness Alliance, which is a non-profit organization focused on societal well-being, developed a happiness index based on the following components: psychological well-being, health, education, time balance, community, social support, environment, governance, material well-being and work (Musikanski et al., 2017).

The index is conveyed by a survey, which anyone can take. At the end of the survey, a score ranging from 0 to 100 (the latter being the best and the former representing the worst) is displayed for each category, which can be compared to the average score of the respective category. The objective of the index is to help policymakers to further perceive what is happiness and to promote better policies with regards to the well-being of the community. However, this index has a limitation, since it is entirely based on a survey which is reliant on non-objective data. In addition, it is not possible to compare scores between countries.

These abovementioned indexes consider at least one subjective component for measuring well-being. In addition, it is not possible to compare well-being throughout time with these indexes.

This thesis will utilize official objective data for OECD countries in the construction of the aggregate index, while allowing to perform comparisons and

benchmarks between the countries from 2018 to 2020. Lastly, it will be compared the results of the aggregate index to the results of the abovementioned indexes.

3. The DEA Method

Data Envelopment Analysis (also known as DEA) was introduced by Farell (1957). Standing on the shoulders of that author, Charnes, Cooper and Rhodes developed the most widely used DEA model, which corresponds to the CCR model (Mardani et al., 2017).

Data Envelopment Analysis is an application of linear programming, where several variables are utilized to measure relative efficiency of the decision-making units (DMU's). In fact, the most extreme points are used to map an efficient frontier, where we can benchmark the units with one another, on a scale ranging from 0 to 1 (where 1 represents the maximum efficiency).

There are two possible orientations for utilizing this method, the input orientation and the output orientation. The first one consists in minimizing the level of inputs for a given level of output. The latter corresponds to a maximization of outputs for a given level of output.

For one input and one output situation, the efficiency is solely the ratio between the output and input. However, while adding several inputs and outputs, the computation of the efficiency becomes more challenging. The following equation presents the CCR model, where efficiency (θ) is defined by:

$$\max \theta_{jo} = \frac{\sum_{m=1}^{M} y_m^{jo} u_m^{jo}}{\sum_{n=1}^{N} x_n^{jo} v_n^{jo}}$$

$$s.t, \frac{\sum_{m=1}^{M} y_m^{j} u_m^{j}}{\sum_{n=1}^{N} x_n^{j} v_n^{j}} \leq 1, j = 1, \dots n$$

Where there are j DMU's, with M outputs $y_1^j, \dots, y_m^j$ that are multiplied by their respective weights $u_1^j, \dots, u_m^j$, and then divided by the N inputs $x_1^j, \dots, x_n^j$ multiplied by their corresponding weights $v_1^j, \dots, v_n^j$. The model is solved for each DMU jo in turn.

The efficiency score is maximized under the constraints that the ratio of weighted outputs to weighted inputs cannot exceed 1, and all inputs and outputs must be non-negative.

The DEA model can also be formulated under different types of returns to scale (RTS). A DMU can operate at constant returns to scale (CRS), if a given increase/decrease in its inputs generate a proportional increase/decrease in its output levels. If this is not the case, it would be recommended to utilize the variable returns to scale (VRS), where an increase/decrease in inputs generate unproportionable increase/decrease in output levels (Gamboa & Iribarren, 2021)

Benefit of the doubt (also known as BOD) is a very useful approach in the DEA framework for the constitution of a composite index, in the sense that it provides the optimum weights for the respective indicators that will be aggregated. Benefit of the Doubt has a peculiarity in which only the DMU's outputs are considered and compared. In fact, the only input is a dummy variable equal to one. Therefore, the following model defines the BOD approach:

$$Max\ h_0 = \sum_{r=1}^{S} u_r\, y_{r0}$$

Subject to: $\sum_{r=1}^{S} u_r y_{rj} \leq 1; \quad j = 1, \dots, n,$

$u_r \geq 0; r = 1, \dots, s.$

The linear programming model utilizes the weights (u_r) that maximize the efficiency score of the DMU under assessment (jo), while taking into consideration the output values of for the DMU (y_{rj}). In DEA, when using a composite index, the framework searches for endogenous weights that maximize the efficiency score of the respective DMUs.

The DEA framework is very popular in operations research, especially in the study of ways to maximize productivity within companies and other entities.

However, empirical applications exist for many other sectors, such as education, economics, logistics, health, athletics, and many more (Banker & Almeida, 2016). For example, Nayar & Ozcan (2008) analyzed a sample of Virginia hospitals in two dimensions, technical efficiency and quality, and concluded that hospitals that were technically efficient were also efficient in producing quality outputs. This has implications for policy since improving technical efficiency did not seem to compromise quality of service.

Therefore, DEA is a very versatile framework that allows the accommodation of several inputs and outputs for benchmarking while observing the best performers (Nayar & Ozcan, 2008). However, it has a limitation in the sense that, for example, in a composite index, some indicators may be ignored completely if the DMUs perform relatively better in other indicators, providing an unbalanced result. Note that this limitation can be mitigated with weight restrictions.

4. Data and Variables

The main purpose of the study is to construct a composite index of well-being and seeing how it relates to other, more simplistic, approaches. For the construction of the composite index, seven indicators will be utilized.

The list of variables is detailed in table 1. Data were gathered for these variables from 2018 to 2020 for the countries that belong to the OECD, except for the ones whose data were not available (for example, Chile, Colombia and Japan for some of the years).

Variable	Type of Variable	Description	Source
GDP per capita, in PPP	Economic	Gross domestic product of a country, converted to international dollars using purchasing power parity, divided by total population	World Bank
GDP per hour worked	Economic	Gross domestic product of a country divided by total hours worked. It measures labor productivity.	OECD
Air Cleanness	Environmental	Variable that measures air quality of a given country on a scale ranging from 0 to 100 (the latter corresponding to perfect air quality), based on the perception of the people.	Gallup
Employment Rate (in %)	Socio-demographic	Variable that displays, for a given country, the percentage of total adult population that is employed.	OECD
Life Expectancy at Birth	Socio-demographic	Variable that exhibits the average number of years that a newborn could expect to live, for a given country.	World Bank
People with Tertiary Education	Socio-demographic	Percentage of people with age ranging from 25 to 34 years old that have completed any type of tertiary education course.	OECD
Social Support	Social	Measures the percentage of people that in a survey, when asked the following question "If you were in trouble do you have relatives or friends you can count on to help you whenever you need them, or not?" answers "yes".	OECD

Table 1. Summary of variables

The economic variables considered are "GDP per capita, in PPP (Purchasing Power Parity)" and "GDP per hour worked". Note that both variables are measured in dollars. It was decided to include a measure of productivity in the aggregate index because our believe is that higher productivity may conduct to higher levels of well-being.

Moreover, "Air cleanness" is an environmental variable utilized for the composite index. The variable ranges from 0 to 100, where the latter corresponds to perfect air quality. This indicator is based on perceptions from visitors of the Gallup website, with data up to 36 months old, complemented with relevant data from World Health Organization.

The other variables are socio-demographic indicators, starting with "Employment Rate (in %)", which is a proxy for economic stability. "Life Expectancy at Birth" is also a socio-demographic indicator utilized in the composite index, which in turn is an important component of the overall health status of a specific country. "People with Tertiary Education (in %)" is an indicator that gives the percentage of individuals, from 25 to 34 years old, that have a post-secondary education, whether it is public or private universities or other technical training institutes. Lastly, "Social Support (in %)" is an indicator which measures the percentage of people that in a survey, when asked the following question "If you were in trouble do you have relatives or friends you can count on to help you whenever you need them, or not?" answers "yes". Note that this was a sample conducted to at least 1000 people from each country.

The variables "GDP per Capita" and "Life Expectancy at Birth" were collected from World Bank, while "GDP per hour worked", "Employment Rate", "Social Support" and "People with Tertiary Education" were gathered from OECD data. Regarding "Air Cleanness", the indicator was gathered from Gallup World Poll.

One other variable was collected for the purpose of complementing the composite index, which corresponds to "Hours worked per worker", and it is shown in table 2.

Variable	Type of Variable	Description	Source
Hours Worked per Worker/Employee	Economic	Variable that displays, for a given country, the total number of hours worked over the year divided by the average number of employed people	OECD

Table 2. Complementary variable

Lastly, the table below allows to observe the number of observations for each year.

	2018	2019	2020
Number of observations	35	35	33

Table 3. Number of observations in the data

4.1. Descriptive Statistics

Before implementing the DEA model, it is useful to grasp how the variables relate to each other, as well as how their measures of central tendency and of dispersion unfolded from 2018 to 2020, for the available OECD countries. Mean and median values of the variables as well as their coefficient of variation can be seen in table 4 below.

Variable	Mean			Median			Coefficient of Variation		
	2018	**2019**	**2020**	**2018**	**2019**	**2020**	**2018**	**2019**	**2020**
GDP per capita (in PPP $)	43 160	46 307	43 756	41 948	42 805	42.381	0,34	0,42	0,33
GDP per Hour Worked	104	109	109	103	104	106	0,04	0,16	0,07
Air Cleanness	63	64	64	67	68	66	0,24	0,24	0,23
Employment Rate (in %)	70	70	70	71	71	71	0,10	0,10	0,09
Life Expectancy at Birth	81	81	80	82	82	81	0,03	0,03	0,03
People with Tertiary Education	44	45	46	44	44	45	0,24	0,23	0,21
Social Support	90	91	92	91	92	94	0,05	0,05	0,06
Hours Worked per Employee	1 702	1 684	1 600	1 708	1 690	1 577	0,12	0,12	0,12

Table 4. Mean, median and coefficient of variation of the variables for the years ranging from 2018 to 2020

As it is possible to notice, the average GDP per capita (in PPP, $) increased from 2018 to 2019, from 43 160$ to 46 307$, decreasing in 2020 to 43 756$. In fact, the positive trend in GDP per capita in 2018 and 2019 was halted due to the COVID-19 pandemic

that took place in 2020. Similarly, GDP per hour worked, which displays labor productivity, increased on average from 2018 to 2019, from 104$ per hour to 109$ per hour, while in 2020 it leveled off at 109$ per hour. The average air cleanness has maintained relatively stable, having a score of 63 points in 2018 and 64 in 2019 and 2020. As for Employment Rate, its average did not vary in a significant manner in that timeframe. In fact, from 2018 to 2020, on average, 70% of adult people of the OECD countries analyzed were employed. On the other hand, the average Life Expectancy at Birth for the OECD countries corresponded to roughly 81 years for 2018 and 2019, decreasing in 2020 to 80 years. This decrease in 2020 was also predominantly due to the abovementioned pandemic. Regarding education, the average percentage of people from 25 to 34 years old that have a tertiary degree increased from 2018 to 2020, passing from 44% to 46%, respectively. In a similar fashion, Social Support, on average, also increased from 2018 to 2020, corresponding to 90% and 92%, respectively. Lastly, the total average hours worked per employee decreased progressively, corresponding to 1 702 hours in 2018, 1 684 hours in 2019 and 1 600 hours in 2020.

The Coefficient of Variation is a relative measure of dispersion that provides the ratio between the standard deviation and the mean. In a sense, it displays the level of dispersion of the data around the mean. In 2020, the variables that are more disperse in relation to the mean are GDP per Capita (in PPP), Air Cleanness and People with Tertiary Education, with 33%, 23% and 21% variation around the respective means. On the other hand, the variables which are less volatile are Life Expectancy at Birth, Social Support and GDP per Hour Worked, with 3%, 6% and 7% variation around the respective means. It is also possible to observe that, for GDP per Capita (in PPP), the data was particularly disperse, representing 42% variation around its mean, while in 2020 it decreased to 33%. Likewise, GDP per hour worked also was particularly disperse in 2019, representing 16% variation around its mean, while in 2020 it decreased to 7%. The remaining variables, from 2018 to 2020, maintained relatively constant coefficients of variation.

In order to assess how the variables relate to each other, the Pearson correlation Coefficient was calculated and is shown in table 5. Note that a value of 0 indicates that there is no correlation between the variables, while 1 and -1 implies that there is a perfect positive and negative (respectively) correlation between them. It is possible to observe that, for example, Social Support is strongly correlated to Employment Rate in a positive way, meaning that when employment rate increases, social support also tends to increase. In addition, Life Expectancy at Birth is moderately correlated with People with Tertiary Education.

	GDP per capita (in PPP $)	GDP per Hour Worked	Air Cleanness	Employment Rate	Life Expectancy at Birth	People with Tertiary Education	Social Support
GDP per capita (in PPP $)	1						
GDP per Hour Worked	-0,07	1					
Air Cleanness	0,47	-0,13	1				
Employment Rate (in %)	0,50	-0,12	0,74	1			
Life Expectancy at Birth	0,50	-0,28	0,28	0,16	1		
People with Tertiary Education	0,49	0,14	0,18	0,25	0,37	1	
Social Support	0,51	0,04	0,61	0,66	0,19	0,13	1
Hours Worked per Employee	-0,42	0,35	-0,60	-0,57	-0,36	-0,11	-0,54

Table 5. Pearson Correlation Coefficient between the variables for the year of 2020

4.2. Comparison between GDP per capita and Average Hours Worked per Employee

Firstly, a compilation of the OECD countries and their GDP's per capita (in $ PPP) were made, as well as their average worked hours per employee, for the year of 2020 (see in table 6).

Country	GDP per capita (PPP)	Hours worked per worker
Australia	53 330	1 683
Austria	55 684	1 400
Belgium	53 035	1 481
Canada	46 103	1 644
Chile	23 325	1 825
Colombia	13 449	2 342
Costa Rica	19 903	1 913
Czech Republic	38 508	1 705
Denmark	55 820	1 346
Estonia	35 215	1 654
Finland	47 144	1 531
France	42 313	1 402
Germany	51 374	1 332
Greece	27 035	1 728
Hungary	31 100	1 660
Iceland	52 381	1 435
Ireland	90 625	1 746
Israel	39 049	1 783
Italy	39 005	1 559
Japan	40 232	1 598
Korea	42 381	1 908
Latvia	30 083	1 577
Lithuania	37 110	1 595
Luxembourg	112 227	1 427
Mexico	17 852	2 124
Netherlands	54 326	1 399
New Zealand	42 775	1 739
Norway	63 548	1 369
Poland	32 355	1 766
Portugal	31 935	1 613
Slovak Republic	30 510	1 572
Slovenia	37 091	1 515
Spain	36 220	1 577
Sweden	50 923	1 424
Switzerland	68 753	1 495
Turkey	28 393	2 304
United Kingdom	42 676	1 367
United States	60 287	1 767

Table 6. OECD countries and their GDP per capita in PPP and hours worked per employee, data for 2020

We can see in the abovementioned table that, in 2020, the OECD countries with higher GDP per capita correspond to Luxembourg, with a GDP per capita of 112.227$, followed by Ireland (90.625$), Switzerland (68.753$) and Norway (63.548$).

On the other hand, the OECD countries with lowest GDP per capita correspond to Colombia, with a GDP per capita of 13 449$, followed by Mexico (17 852$), Costa Rica (19 903$) and Chile (23 325$).

Regarding average hours worked in 2020 per employee, it is possible to observe that Mexico is the country where most hours are spent working (2 124 hours), followed by Costa Rica (1 913 hours). On the other hand, Germany and Denmark are the countries that, on average, employees work less hours (1 332 and 1 346 hours, respectively).

In Figure 1 we plotted each country with their average working hours per employee and their corresponding GDP per capita.

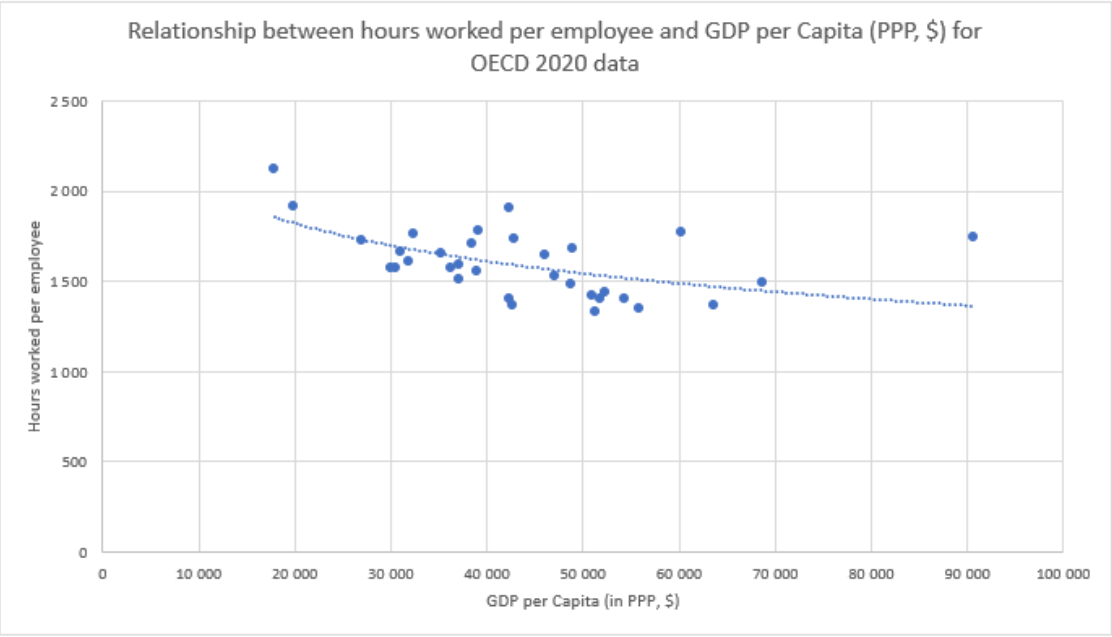

Figure 1. Country comparison in hours worked per employee and GDP per capita in PPP, data for 2020

Curiously, it is possible to notice that the abovementioned countries with higher GDP per capita are the ones that work less hours on average. In fact, Luxembourg employees, in a year, work, on average, 1 427 hours. For Switzerland, average working hours per year correspond to 1 495 hours, while for Norway the average yearly working hours correspond to 1 369 hours. Notice that the average working hours in a year for the OECD countries correspond to 1 600 hours per year, which means that the abovementioned countries are well below the average. The only country with higher GDP per capita that has above average working hours is Ireland, with a GDP per capita of 90 625$ and 1 746 average hours worked per employee.

However, it is possible to verify in the graph that the countries with lowest GPD per capita are the ones that exhibit the most working hours. This is the case for Mexico and Costa Rica, with 17 852$ and 19 903$ GDP per capita, and 2 124 and 1 913 hours worked on average per employee, respectively.

Therefore, it is possible to ascertain a negative slope between these two variables.

Figures 2 and 3 correspond to the relationship between the hours worked per employee and GDP per capita for 2019 and 2018, respectively. It is possible to observe that the results are very similar to 2020, showing a consistent negative slope between the two variables.

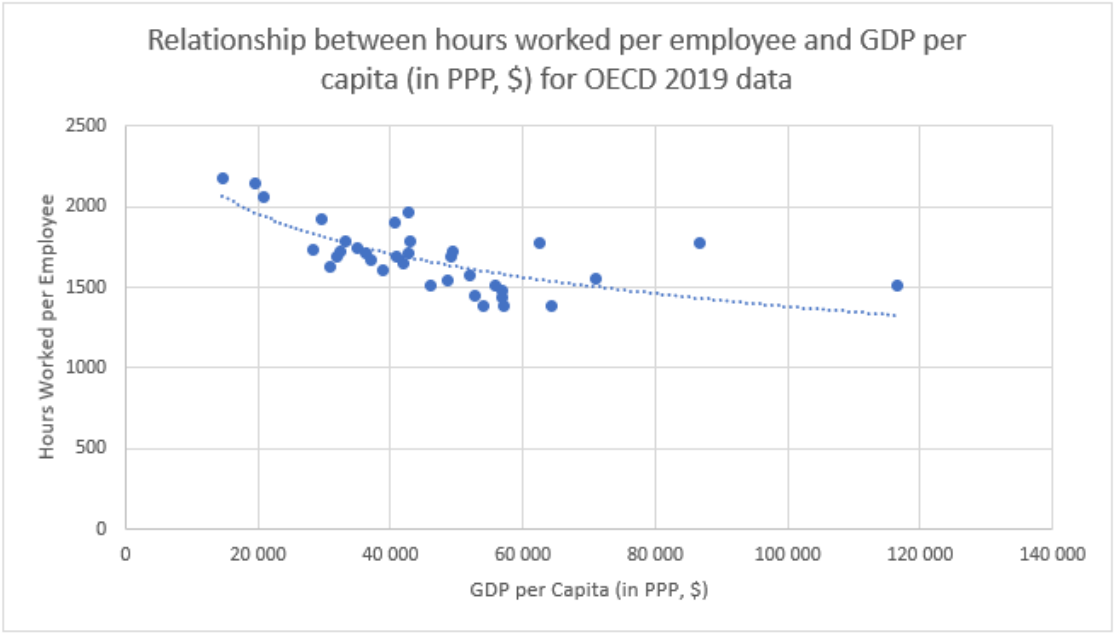

Figure 2. Country comparison in hours worked per employee and GDP per capita in PPP, data for 2019

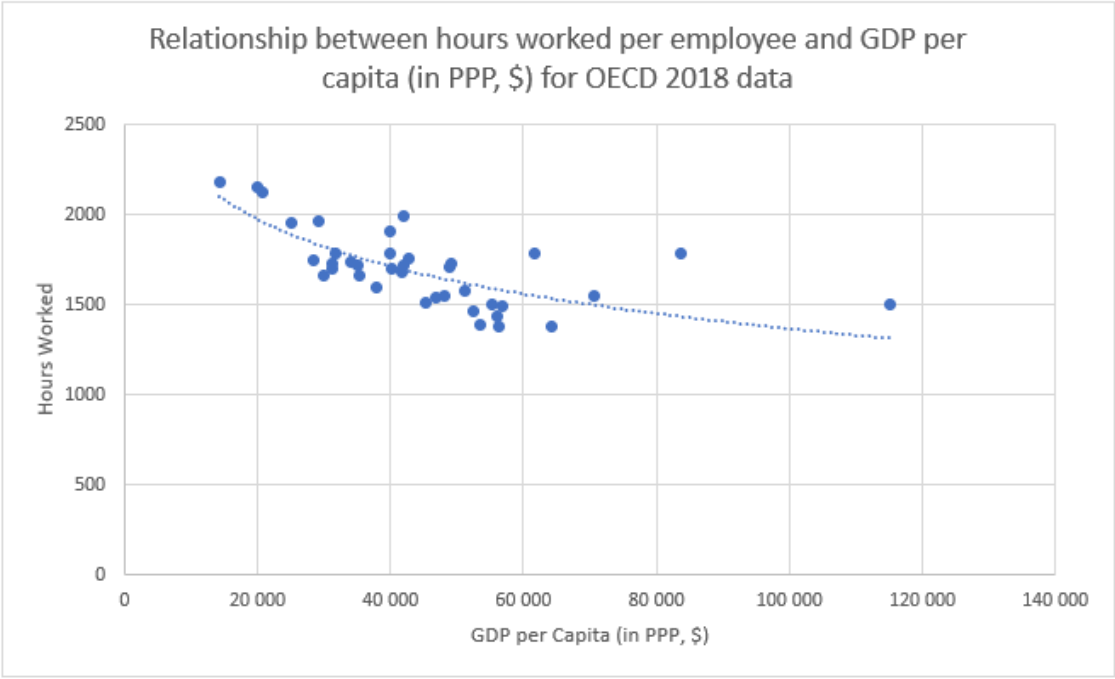

Figure 3. Country comparison in hours worked per employee and GDP per capita in PPP, data for 2018

In addition, looking at table 7, one can conclude that the average GDP per capita (in PPP, $) in OECD countries increased from 2018 to 2019, passing from 44 935$ to 46 307$. In 2020, the average GDP per capita decreased to 43 756$ due to the worldwide COVID-19 pandemic conjuncture. Furthermore, the average hours per worker decreased from 2018 to 2020, passing from 1 698h in 2018 to 1 684h in 2019 and, finally, to 1 600h in 2020.

	Average GDP per Capita (in PPP, $)	Total Average hours worked per employee (in hours)
2018	44 935	1 698
2019	46 307	1 684
2020	43 756	1 600

Table 7. Average GDP per Capita (in PPP, $) and total average hours worked per employee (in hours), for OECD data ranging from 2018 to 2020.

It was possible to observe that there is a negative relationship between GDP per capita and the average hours worked per employee, that is the reason why will consider a variable of productivity (GDP per hour worked) in our DEA model, instead of the average hours worked per employee.

5. An objective well-being index - Results

5.1.Benefit of the Doubt with no weight restriction

For the composition of an aggregate index, the Benefit of the Doubt approach was utilized through the software EMS (Efficiency Measurement System).

The outputs that were considered correspond to "GDP per capita (in PPP, $)", "GDP per hour worked", "Employment Rate (in %)", "Air Cleanness", "Life Expectancy at Birth", "Social Support" and "People with Tertiary Education". The BOD approach will consider data for these variables for the years between 2018 and 2020 simultaneously, therefore there will not be models for each year.

Note that for this first approach of BOD will not consider any weight restrictions and will be input oriented. After running the model, we obtain the results shown in table 8.

DMU	Well-being Score
Canada (2020)	100%
Finland (2020)	100%
Iceland (2020)	100%
Ireland (2020)	100%
Korea (2020)	100%
Norway (2020)	100%
Australia (2019)	100%
Canada (2019)	100%
Finland (2019)	100%
Iceland (2019)	100%
Japan (2019)	100%
Korea (2019)	100%
Luxembourg (2019)	100%
Switzerland (2019)	100%
Korea (2018)	100%
Norway (2018)	100%
Colombia (2019)	91,49%
Colombia (2018)	91,24%
Latvia (2018)	90,91%
Mexico (2018)	89,61%
Mexico (2019)	89,45%
Mexico (2020)	88,98%

Table 8. Benefit of the Doubt approach without weight restrictions

The table above displays the DMUs that are at the frontier, i.e., with highest well-being score, as well as the DMUs with lowest well-being score. The lowest scores are relatively high meaning that the model is not able to find much discrimination between the well-being performance of countries. The DMUs that are at the frontier correspond to 2020 data from Canada, Finland, Iceland, Ireland, Korea and Norway.

In addition, 2019 data from Austria, Canada, Finland, Iceland, Japan, Korea, Luxembourg and Switzerland are also at the frontier. Lastly, the countries for which data of 2018 is at the frontier correspond only to Korea and Norway. The other DMUs have lower well-being scores, with the lowest corresponding to Mexico in 2020, with a well-being score of 88,98%.

In table below, it is possible to observe the top 10 countries which increased their well-being the most from 2018 to 2020.

DMU	Well-Being Score 2018	Well-Being Score 2020	Evolution
Poland	92,50%	96,63%	+ 4,13%
Slovak Republic	92,85%	96,89%	+ 4,04%
Latvia	90,91%	94,83%	+ 3,92%
Czech Republic	94,81%	98,01%	+ 3,20%
USA	94,46%	96,85%	+ 2,39%
Lithuania	94,22%	95,70%	+ 1,48%
UK	97,09%	98,15%	+ 1,06%
Israel	98,46%	99,36%	+ 0,90%
Netherlands	97,89%	98,76%	+ 0,87%
Estonia	97,06%	97,87%	+ 0,81%

Table 9. Top 10 countries which well-being score increased the most

Poland was the country that increased its well-being the most, in 4,13%. Slovak Republic was the second-best country in terms of evolution, passing in 2018 from 92,85% to 96,89%, followed by Latvia that increased its well-being score in 3,92%. This increase in well-being was primarily due to an increase in social support which, as we are going to see further ahead, is the indicator with more weight assigned to the composite index. In fact, for example, Latvia increased its social support from 2018 to 2020, from 88,15 to 92 (increase of 4,4%).

DMU	Well-Being Score 2018	Well-Being Score 2020	Evolution
Italy	99,08%	97,41%	-1,67%
Spain	99,18%	97,85%	-1,33%
Greece	97,04%	95,98%	-1,06%
Belgium	97,25%	96,36%	-0,89%
Austria	97,53%	96,77%	-0,76%
Mexico	89,61%	88,98%	-0,63%
Portugal	96,72%	96,28%	-0,44%

Table 10. Countries for which well-being score decreased the most

On the other hand, Italy, Spain and Greece were the countries which decreased their well-being score the most, from 2018 to 2020 (see table 10). Note that the well-being score of Italy decreased in 1,67%, whereas Spain decreased 1,33% and, lastly, Greece decreased by 1,06%. This negative evolution was primarily due to the decrease in social support (e.g., Italy decreased 90,68 to 89, in 1,8%), air cleanness and life expectancy. Note that life expectancy at birth decreased significantly in these 3 countries, highlighting Italy which decreased from 83,4 years in 2018 to 82 years in 2020, largely due to the COVID-19 pandemic.

Highlighting Portugal, from 2018 to 2019 it increased its well-being score, passing from 96,72% to 97,16%, declining in 2020 to 96,28%. Note that the average well-being score for the OECD countries is 97,25%. The variable which Portugal attributes more weight corresponds to "Life Expectancy at Birth" since it performs relatively better compared to the other variables. Since, from 2018 to 2020, that attribute decreased from 81,4 years to 81 years, it decreased its overall well-being score in that time period.

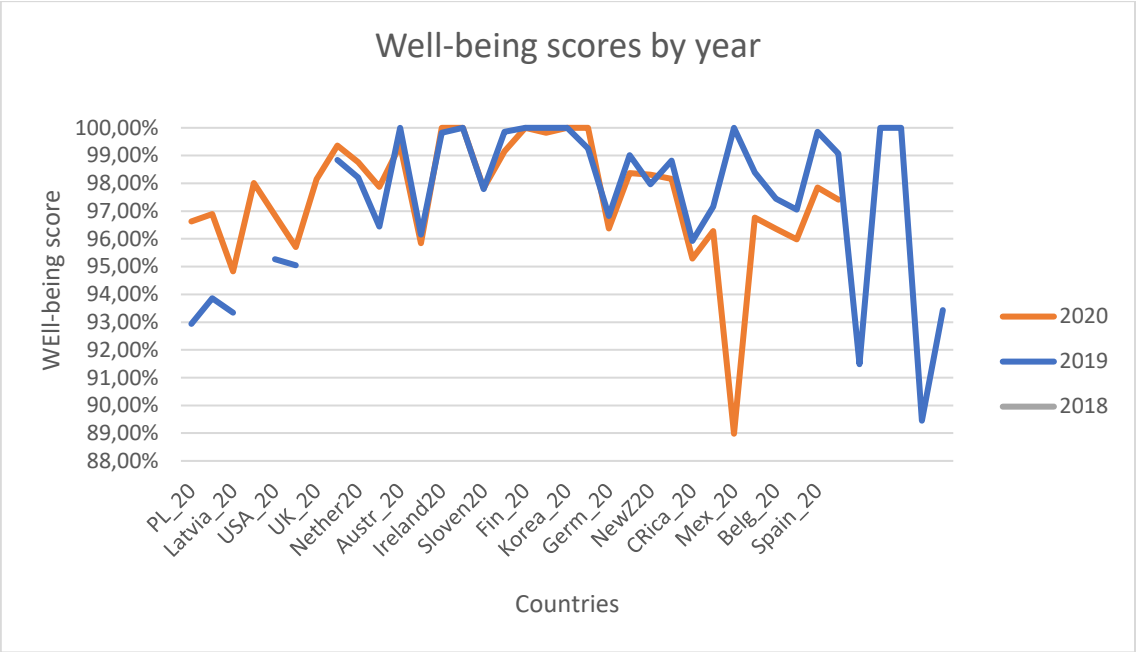

Figure 4. Well-being scores by year

As we can see in figure 4, the best year in terms of well-being scores was 2019, which displayed an average of 97,39%. One can observe that from 2018 to 2019 there was a global increase in well-being scores, later decreasing in 2020. Note that the indicator which decreased the most from 2019 to 2020 was GDP per capita, with a negative evolution in that time period of 5,51%, mostly due to the COVID-19 pandemic.

One useful tool in EMS is the fact that one can obtain the benchmarks for each DMU. For example, for Portugal in 2020, its benchmark corresponds to "Australia_19", "Japan_19" and "Switzerland_19". In fact, since Portugal attributes weights to the variables "GDP per hour worked", "Air Cleanness" and "Life Expectancy at Birth", its benchmarks correspond to DMU's which are relatively strong in those indicators. For example, the DMU "Australia_19" attributes a more significant weight in "GDP per hour worked", while the DMU "Japan_19" is efficient and attributes weight to the variable "Air Cleanness". Lastly, the DMU "Switzerland_19" attributes a significant weight to the variable "Life Expectancy at Birth".

This approach has a limitation in the sense that the DMU's attribute weight to more convenient variables, i.e., to the variables in which they perform relatively better. For instance, for all of the DMUs the one which has more GDP per capita is Luxembourg in 2019, so that DMU attributes all its weight in that indicator, disregarding the other indicators where it performs not so relatively well. In fact, all DMUs ignore at least one variable.

In table 11 we can see, for 2020 data, the results for the top 10 countries in terms of well-being scores. As we can observe, eight out of the top 10 DMUs completely ignore the variable "GDP per capita" and "Employment Rate". The less ignored the variable corresponds to "People with Tertiary Education", in which only Iceland attributes zero weight. In addition, in the same table it is possible to observe that "Social Support", for the top 10 most efficient countries, the average weight that the DMUs give to that variable corresponds to 29,98%. For "People with Tertiary Education", the weight is 26,72% while for "Air Cleanness" is 22,94%. On the other hand, "Employment Rate" has an average weight of 4,32%, "GDP per hour worked" corresponds to 3,55% and "GDP per capita" has 1,01%, being the indicator with the smallest weight on average.

Country	GDP per capita (PPP)	GDP per hour worked	Employment Rate (in %)	Air Cleanness (higher the Better)	Life Expectancy at Birth (in years)	Social Support (in percentage)	People with Tertiary Education (25-34 years old, in %)
Canada	0,00%	10,93%	0,00%	22,26%	0,00%	0,00%	66,81%
Finland	0,00%	0,00%	0,00%	63,92%	0,00%	13,27%	22,82%
Iceland	0,00%	0,00%	0,00%	0,00%	0,00%	100,00%	0,00%
Ireland	8,72%	7,10%	0,00%	0,00%	0,00%	54,08%	30,10%
Korea	0,00%	12,99%	0,00%	0,00%	0,00%	26,35%	60,66%
Norway	1,36%	0,00%	0,00%	16,35%	8,74%	60,16%	13,39%
Switzerland	0,00%	3,29%	21,52%	47,70%	0,00%	0,00%	27,50%
Austria	0,00%	0,00%	0,00%	27,12%	56,89%	0,00%	15,99%
Israel	0,00%	1,20%	0,00%	0,00%	49,22%	45,92%	3,67%
Sweden	0,00%	0,00%	21,68%	52,06%	0,00%	0,00%	26,26%
Average weight	**1,01%**	**3,55%**	**4,32%**	**22,94%**	**11,49%**	**29,98%**	**26,72%**

Table 11. Comparison of the virtual weights assigned to each variable by the countries at the frontier for 2020

5.2.Benefit of the Doubt Approach with Weight Restrictions

One particularity of EMS software is that one can specify weight restrictions in a relative manner to the weights of the outputs. Therefore, for the eight variables (v1 corresponding to the weight of GDP per Capita and v8 corresponding to the weight of People with Tertiary Education), if we want GDP per capita to have a superior weight to People with Tertiary Education, we have the following condition: v1 > v8.

In order to make the variables have a narrower range of weight discrepancy between them, weight restrictions will be applied in a way that a variable can have a minimum weight of half of another, and a maximum weight of 1,5 of the weight of any other variable.

The results of the application of the BOD approach with this form of weight restrictions can be seen in the figure 12 below.

DMU	**Well-being Score**
Luxembourg (2019)	100%
Ireland (2020)	77,99%
Ireland (2019)	74,59%
Ireland (2018)	72,10%
Switzerland (2019)	61,24%
Switzerland (2018)	60,93%
Switzerland (2020)	59,37%
Norway (2019)	55,63%
Norway (2018)	55,60%
Norway (2020)	54,93%
Mexico (2018)	17,61%
Mexico (2019)	17,40%
Mexico (2020)	15,83%

Colombia (2019)	13,11%
Colombia (2018)	12,87%

Table 12. Benefit of the Doubt approach with weight restrictions

As it can be seen, with the weight restrictions, the well-being scores are much lower compared to the scenario without weight restrictions, since no variable is ignored in terms of weight. In fact, the average well-being score is now 38,59%, instead of 97,25% in the latter scenario. The only DMU with a well-being score of 100% is Luxembourg in 2019, which means it is the most balanced DMU or, in other words, it performs relatively well in all dimensions. Note that the benchmark for every DMU corresponds to Luxembourg in 2019. On the other hand, the DMUs with worst well-being scores correspond to Colombia in 2018, 2019, and Mexico in 2020, 2019 and 2018, which is very similar to the scenario without weight restrictions.

In the table below one can see the top 10 DMUs for the scenario with weight restrictions, for the year of 2020. Note that EMS only supports weight restrictions for pure weights.

DMU	Well-Being Score	GDP per capita	GDP per hour worked	Employment Rate	Air Cleanness (higher the Better)	Life Expectancy at Birth	Social Support	People with Tertiary Education
Ireland	77,99%	0,00001092	0,00002183	0,00002183	0,00002183	0,00002183	0,00002183	0,00002183
Switzerland	59,37%	0,00001434	0,00002868	0,00002868	0,00002868	0,00002868	0,00002868	0,00002868
Norway	54,93%	0,0000155	0,000031	0,000031	0,000031	0,000031	0,000031	0,000031
USA	52,11%	0,00001634	0,00003268	0,00003268	0,00003268	0,00003268	0,00003268	0,00003268
Denmark	48,34%	0,00001761	0,00003522	0,00003522	0,00003522	0,00003522	0,00003522	0,00003522
Netherlands	47,06%	0,00001809	0,00003618	0,00003618	0,00003618	0,00003618	0,00003618	0,00003618
Iceland	45,43%	0,00001874	0,00003748	0,00003748	0,00003748	0,00003748	0,00003748	0,00003748
Austria	44,94%	0,00001894	0,00003788	0,00003788	0,00003788	0,00003788	0,00003788	0,00003788
Germany	44,52%	0,00001912	0,00003825	0,00003825	0,00003825	0,00003825	0,00003825	0,00003825
Sweden	44,18%	0,00001927	0,00003854	0,00003854	0,00003854	0,00003854	0,00003854	0,00003854

Table 13. Comparison of the pure weights assigned to each variable by the countries at the frontier for 2020

As it is possible to observe, the weights attributed to each variable are very balanced and similar to each other. However, it is noticeable that GDP per capita continues to be the variable with less weight.

Compared to the scenario without weight restrictions, Canada is no longer in the top 10 DMUs of 2020 in relation of well-being scores, as well as Finland, Korea and Israel. On the other hand, Netherlands, USA and Germany, with the weight restrictions became part of the top 10 DMUs.

In the case of Portugal, with the weight restrictions, it attained a well-being score of 29,74% in 2018, 30,51% in 2019 and 27,96%, being a very similar evolution with the scenario without weight restrictions. In addition, the variable GDP per capita is the variable in which Portugal performs relatively worse, thus it is the variable with less weight.

5.3. Comparison with Other Indexes

5.3.1. Better-Life Index (BLI)

Better-life index, as mentioned in the literature review, depends on the inputs of the users, i.e., it depends on the preferences of the users in regard to health, civic engagement, environment, and even life satisfaction. When we attribute the same weight to all the dimensions, it is possible to observe that the top 5 countries are Norway, Iceland, Switzerland, Sweden and Finland (see figure 5 below).

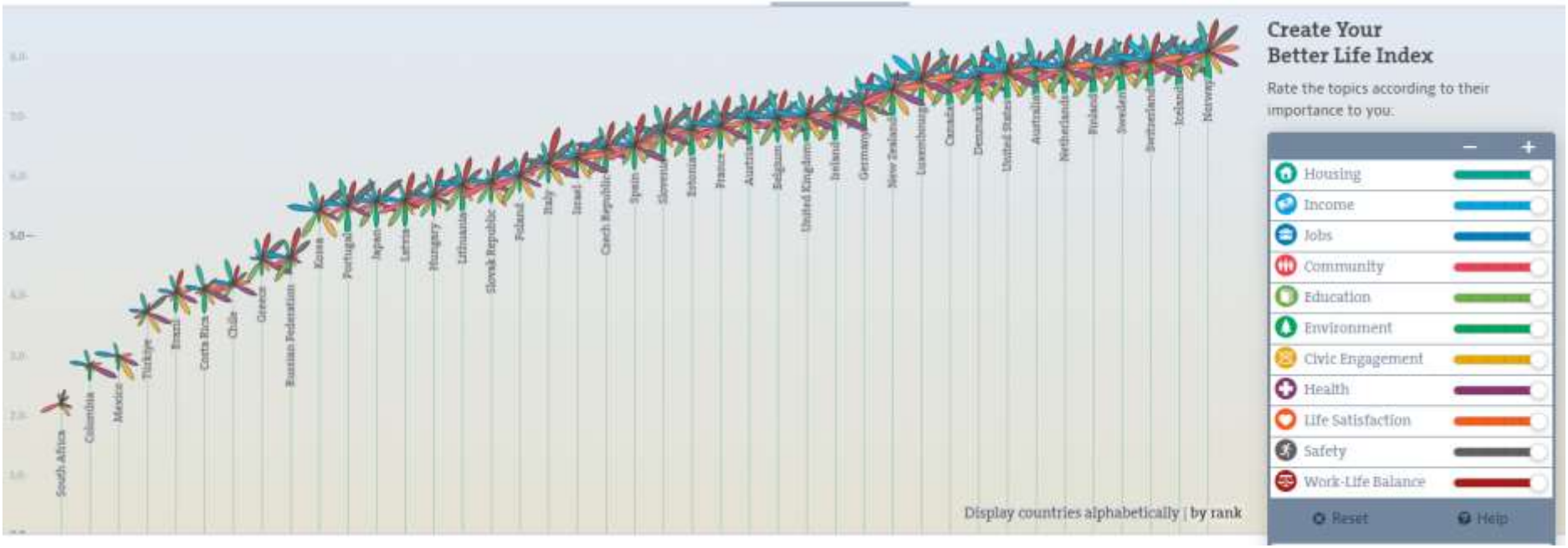

Figure 5. Results of Better-Life Index

Interestingly, all of these countries, with the exception of Finland, are included in the top 10 most efficient countries (as can be seen in table 14). In addition, the worst countries according to BLI correspond to Colombia and Mexico, which is also in accordance with the results discussed above.

5.3.2. Our World in Data

Our World in Data performed a World Happiness Report in which a survey was undertaken by more than 160 countries. The survey is entirely subjective, since the question was the following "Please imagine a ladder, with steps numbered from 0 at the bottom to 10 at the top. The top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. On which step of the ladder would you say you personally feel you stand at this time?" (also known as "Cantril Ladder").

According to the poll, the top 5 countries are Denmark, Finland, Switzerland, Netherlands and Canada, which is very similar to the best performing countries in the DEA model.

Scenario without WR	**Scenario with WR**	**BLI**	**Happiness Report by Our World in Data**
Canada	Ireland	Norway	Denmark
Finland	Switzerland	Iceland	Finland
Iceland	Norway	Switzerland	Switzerland
Ireland	USA	Sweden	Netherlands
Korea	Denmark	Finland	Canada
Norway	Netherlands	Netherlands	Norway
Switzerland	Iceland	Australia	Sweden
Austria	Austria	USA	Australia
Israel	Germany	Denmark	New Zealand
Sweden	Sweden	Canada	Belgium

Table 14. Top 10 countries in accordance with DEA models and other indexes

Looking at the abovementioned table, it is possible to conclude that, for the top 10 best performing countries, there is a correspondence of 60% between the DEA model without weight restrictions and the BLI, and 70% for the scenario with weight restrictions.

6. Conclusion

The level of well-being of the individual is a growing concern in society which is being studied at a faster momentum. In this manuscript, we have utilized the Benefit of the Doubt (BOD) approach to assemble an objective well-being composite index and, subsequently, evaluate the well-being scores of OECD countries between 2018 and 2020. Several variables were used for the assembly of the composite index, namely economic, social, environmental and socio-demographic variables. One of the main advantages of using DEA consists in the fact that each Decision-Making Unit (DMU) is able to benchmark itself with the best performers, applying the necessary weights to optimize well-being. This allows for a less subjective evaluation of well-being.

We considered two scenarios, the first consisting in not attributing weights to the indicators, and the second which consisted in the imputation of similar weights to each variable. The latter exhibited the most similarity with various well known well-being indexes, showing a 70% correspondence when comparing the top tier performers regarding well-being.

Among the OECD countries, we identified 16 DMUs as the ones with higher well-being score. In fact, for 2020 we identified Canada, Finland, Iceland, Ireland, Korea and Norway. For 2019, Australia, Canada, Finland, Iceland, Japan, Korea, Luxembourg and Switzerland were the best performers, while in 2018 it corresponded to Korea and Norway.

Regarding the evolution of well-being scores from 2018 to 2020, it was evident that there was a general increase from 2018 to 2019. However, the overall decrease of indicators such as social support and GDP per capita, as consequence of the COVID-19 pandemic, manifested in a general decrease on the well-being scores from 2018 to 2020. Notwithstanding, The DMUs which increased its well-being score the most from 2018 to 2020 correspond to Poland, Slovak Republic and Latvia, among others, which

increased in that time period in roughly 4%. On the other hand, the DMUs which decreased the most correspond to Italy, Spain and Greece, among others, which decreased in roughly 1%.

Regarding the variables used to construct the composite index, we verified that social support was the one which, on average, had the biggest weight assigned, corresponding to 29,98%. People with tertiary education and air cleanness followed with an average of 26,72% and 22,94%, respectively. On the other hand, we verified that GDP per capita is not very influent on the composite index, having, on average, a weight of 1,01%. Therefore, in order to increase the well-being score of a DMU in the composite index, the best overall approach should primarily consist in increasing the level of social support, tertiary education and air cleanness.

References

Aristotle, ., Ross, W. D., & Brown, L. (2009). *The Nicomachean ethics*. Oxford: Oxford University Press.

Brayfield, A. H., & Crockett, W. H. (1955). Employee attitudes and employee performance. *Psychological Bulletin*, *52*(5), 396–424. https://doi.org/10.1037/h0045899

Banker, R., & Almeida, M. R. De. (2016). Data Envelopment Analysis and its applications. *Aston Business School*, *May*. https://doi.org/10.13140/RG.2.1.4082.9202/2

Comin, D. (2006). Total Factor Productivity. *NBER*. https://doi.org/10.1016/s0002-8223(21)01295-5

Diener, E., Suh, E. M., Lucas, R. E., & Smith, H. L. (1999). Subjective Well-Being: Three Decades of Progress. *Psychological Bulletin*, *125*(2), 276–302. https://doi.org/10.1006/pupt.1998.0157

Diener, Ed. (1994). Assessing subjective well-being: Progress and opportunities. *Social Indicators Research*, *31*(2), 103–157. https://doi.org/10.1007/BF01207052

Diener, Ed, Tay, L., & Oishi, S. (2013). Rising income and the subjective well-being of nations. *Journal of Personality and Social Psychology*, *104*(2), 267–276. https://doi.org/10.1037/a0030487

DiMaria, C. H., Peroni, C., & Sarracino, F. (2020). Happiness Matters: Productivity Gains from Subjective Well-Being. *Journal of Happiness Studies*, *21*(1), 139–160. https://doi.org/10.1007/s10902-019-00074-1

Easterlin, R. A., McVey, L. A., Switek, M., Sawangfa, O., & Zweig, J. S. (2010). The happiness - Income paradox revisited. *Proceedings of the National Academy of*

Sciences of the United States of America, *107*(52), 22463–22468. https://doi.org/10.1073/pnas.1015962107

Gamboa, M. M. & Iribarren, D. (2021). Data Envelopment Analysis. *Measuring Sustainable Development Goals Performance*

Hills, P., & Argyle, M. (2001). Emotional stability as a major dimension of happiness. *Personality and Individual Differences*, *31*(8), 1357–1364. https://doi.org/10.1016/S0191-8869(00)00229-4

Kim-Prieto, C., Diener, E., Tamir, M., Scollon, C., & Diener, M. (2005). Integrating the diverse definitions of happiness: A time-sequential framework of subjective well-being. *Journal of Happiness Studies*, *6*(3), 261–300. https://doi.org/10.1007/s10902-005-7226-8

Korkmaz, S., & Korkmaz, O. (2017). The Relationship between Labor Productivity and Economic Growth in OECD Countries. *International Journal of Economics and Finance*, *9*(5), 71. https://doi.org/10.5539/ijef.v9n5p71

Koronakos, G., Smirlis, Y., Sotiros, D., & Despotis, D. K. (2020). Assessment of OECD Better Life Index by incorporating public opinion. *Socio-Economic Planning Sciences*, *70*(March 2019), 100699. https://doi.org/10.1016/j.seps.2019.03.005

Krugman, P. (1994). Defining and measuring productivity. *Organisation for Economic Co-Operation and Development*, 1. http://www.oecd.org/std/productivity-stats/40526851.pdf

Lucas, R., Diener, E. (2003). The happy worker: hypotheses about the role of positive affect in worker productivity. *Personality and Work: Reconsidering the Role of Personality in Organizations*

Mardani, A., Zavadskas, E. K., Streimikiene, D., Jusoh, A., & Khoshnoudi, M. (2017). A comprehensive review of data envelopment analysis (DEA) approach in energy efficiency. *Renewable and Sustainable Energy Reviews*, *70*, 1298–1322.

https://doi.org/10.1016/j.rser.2016.12.030

Musikanski, L., Cloutier, S., Bejarano, E., Briggs, D., Colbert, J., Strasser, G., & Russell, S. (2017). Happiness Index Methodology. *Journal of Social Change*, *9*(1), 4–31. https://doi.org/10.5590/josc.2017.09.1.02

Nayar, P., & Ozcan, Y. A. (2008). Data envelopment analysis comparison of hospital efficiency and quality. *Journal of Medical Systems*, *32*(3), 193–199. https://doi.org/10.1007/s10916-007-9122-8

Ortiz-Ospina, E., Roser, M. (2017, May). *Happiness and Life Satisfaction*. Our World in Data. https://ourworldindata.org/happiness-and-life-satisfaction#the-link-across-countries

Oswald, A. J., Proto, E., & Sgroi, D. (2015). Happiness and productivity. *Journal of Labor Economics*, *33*(4), 789–822. https://doi.org/10.1086/681096

Ovaska, T., & Takashima, R. (2006). Economic policy and the level of self-perceived well-being: An international comparison. *Journal of Socio-Economics*, *35*(2), 308–325. https://doi.org/10.1016/j.socec.2005.11.054

Piekałkiewicz, M. (2017). Why do economists study happiness? *Economic and Labour Relations Review*, *28*(3), 361–377. https://doi.org/10.1177/1035304617717130

Rayo, B. L., & Becker, G. S. (2007). Habits , Peers , and Happiness : An Evolutionary Perspective. *The American Economic Review*, *97*(2), 487–491.

Ura, K., Alkire, S., & Zangmo, T. (2012). GNH and GNH Index. *The Centre for Bhutan Studies*, *May*, 1–60.

van Hoorn, A. (2008). A Short Introduction to Subjective Well-Being: Its Measurement, Correlates and Policy Uses. *Statistics, Knowledge and Policy 2007: Measuring and Fostering the Progress of Societies*, *July*, 215–229.

Wright, T. A., & Staw, B. M. (1999). Affect and favorable work outcomes: Two longitudinal tests of the happy-productive worker thesis. *Journal of Organizational Behavior*, *20*(1), 1–23. https://doi.org/10.1002/(SICI)1099-1379(199901)20:1<1::AID-JOB885>3.0.CO;2-W

Annex

Annex 1: Summary of studies at micro and macro level

Reference	Micro/Macro level	Variables used	Methodology employed	Sample size	Country(ies) analyzed	Time period	Main conclusions
Wright, T. A., & Staw, B. M. (1999)	Micro level	Affective state (PANAS scale for measuring); affective disposition (Berkman scale); performance measure (measured by management assessing the workers in their tasks)	Regression Analysis	53	N/A	4 years	Affective disposition (i.e., mental health) is a better indicator for predicting the performance of a given worker
Oswald, A. J., Proto, E., & Sgroi, D. (2015)	Micro level	Treatment dummy, Placebo clip, Male, GMAT, etc,	Regression Analysis	713	N/A	Several years	Subjects that received positive (happy) shocks increased the

							productivity the most (in approximately 12%)
Hills, P., & Argyle, M. (2001)	Micro level	Emotional stability, extraversion, Satisfaction with life, self-esteem, OHI	Factor Analysis, Regression Analysis	240 (plus friend and acquaintances)	N/A		Neuroticism (which is the trait disposition to experience negative effects) is a stronger predictor of Happiness than extraversion
Easterlin, R. A., McVey, L. A., Switek, M., Sawangfa, O., & Zweig, J. S. (2010)	Macro level	Financial satisfaction, life satisfaciton	Regression Analysis	57 countiries	17 Latin American countries, 17 developed countries, 11 Eastern European countries, and 9 less developed countries	Periods ranging from 12 years to 34 years, up to 2005	In the short term, happiness and subjective well-being are positively correlated. However, in the long-term, i.e., more than 10 years, the relationship is null.
DiMaria, C. H., Peroni, C., & Sarracino, F. (2020)	Macro level	Total Factor Productivity (GDP, labour, and capital) Life satisfcation	DEA, Regression Analysis	20 countries	20 European countries	2004-2010	When subjective well-being is an input to production, productivity increases. The contrary is not true.

Koronakos, G., Smirlis, Y., Sotiros, D., & Despotis, D. K. (2020)	Macro level	Better Life Index (from OECD) variables, such as life satisfaction, air pollution, household net adjusted disposable income, etc.	Multiple Objective Programming (MOP)	38 countries	38 countries (35 OECD countries and 3 non-OECD countries)	2017	Public opinion, for purposes of weight restrictions, can effectively drive the optimization process and portray the collective preferences to the Better-Life Index scores.