*sustainability*

MDPI

*Article*

# Development Indexes, Environmental Cost Impact, and Well-Being: Trends and Comparisons in Italy

**Marco Filippo Torchio [1,*], Umberto Lucia [1,*,†] and Giulia Grisolia [2,*,†]**

1 Dipartimento Energia "Galileo Ferraris", Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy
2 Dipartimento di Ingegneria dell'Ambiente, del Territorio e delle Infrastrutture, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy
* Correspondence: marco.torchio@polito.it (M.F.T.); umberto.lucia@polito.it (U.L.); giulia.grisolia@polito.it (G.G.); Tel.: +39-011-090-4558 (U.L.); +39-011-090-7629 (G.G.)
† And also INFN—Sezione di Torino.

**Abstract:** In 1990, the United Nations (UN) presented the Human Development Index ($HDI$) as a measure of human development that considers three fundamental dimensions: a long and healthy life, being knowledgeable, and having a decent standard of living. This paper proposes some considerations about human well-being factors based on $HDI$ analysis, also introducing some considerations on environmental pollution. As regards environmental issues, two different pollutants are considered together with their environmental costs: (i) greenhouse gas (GHG) emissions, which have an impact on a global scale, and (ii) emissions from fine particulate matter, primarily having an impact on a local scale. Thus, a new index based on the external environmental costs is proposed, and two scenarios are discussed. On the other hand, as it concerns human well-being, the results of surveys among the population are used. Furthermore, other features regarding health services and demographic aspects are taken into account, too. Italy is analysed as a case study over the last three decades. Easterlin's considerations are verified based on the variation of perceived well-being related to the changes in $GDP$. The Italian case study shows that despite having achieved a satisfactory $HDI$ level, there is a wide margin for improvement from both the environmental and the well-being standpoints.

**Keywords:** happiness; wealth; Human Development Index; sustainability; Environmental Cost Index

check for updates

**Citation:** Torchio, M.F.; Lucia, U.; Grisolia, G. Development Indexes, Environmental Cost Impact, and Well-Being: Trends and Comparisons in Italy. *Sustainability* **2024**, *16*, 4380. https://doi.org/10.3390/su16114380

Academic Editor: Anna Mazzi

Received: 25 March 2024
Revised: 19 May 2024
Accepted: 20 May 2024
Published: 22 May 2024



## 1. Introduction

In 1974, Richard Ainley Easterlin proposed the first pioneering study on happiness in economics by introducing a paradox that can be outlined as follows [1]: at one time, happiness varies directly with income, both within and among countries, but over time, happiness does not grow with income increases. This means that higher incomes do not produce greater happiness over time [2,3]. The original study was based on U.S. data from 1946 to 1970, and this evidence was confirmed in a later analysis based on 21st century data related both to the U.S.A. and to other countries that are industrialised or in a socio-economic transition.

Two possible explanations have been conjectured:

- The effect of additional money is not related to the personal wealthy condition but to a comparison of the condition among different people [4];
- The effect of additional money is related to obtaining holdings, but it is not able to determine an increase in personal well-being [5].

Some criticisms have been levelled at the Easterlin paradox, in particular the following:

- The time series in happiness and income are not related [6–8];

- Some data show no evidence of a threshold in contrast to the hypothesis that the happiness trend occurs after some minimum level of income [9,10].

Against these criticisms, Easterlin highlighted that the analyses used to comment on the paradox are based on insufficient observations to establish a real trend [2].

One of the present compelling global concerns is ensuring high levels of human well-being without overburdening natural resources; moreover, recently, the focus has shifted towards nonmonetary attributes, i.e., human well-being [11]. So, a continuous growing interest in quality of life and well-being indicators is arising, going beyond gross domestic product ($GDP$), due to the recognition that the $GDP$ represents solely an economic indicator that shows a partial perspective of the different facets of people's lives [12]. Thus, to avoid difficulties in relation to the socio-economic measurement of a country's well-being, in 1990, the United Nations (UN) introduced the Human Development Index ($HDI$), an index that measures the socio-economic conditions of a country by using the geometric mean of three indexes, the Expectancy of Life Index ($LEI$), the Education Index ($EI$), and the Income Index ($II$).

A deep and critical analysis of some indicators, including the $HDI$, was carried out in Refs. [13–16], also recognizing their limits [16]; consequently, some new approaches were introduced [17,18], e.g., in Ref. [19], the relationship between residential energy use per capita and human well-being was studied by using the $HDI$ in the 27 European Union member countries over the years 2000–2018. In addition, considerations on the Education Index were developed [20] by introducing the data available from the OECD's Programme for International Student Assessment (PISA), and then a comparison between European and non-European countries was analysed, focusing on government education spending [21].

Concerning human well-being, a particular interest is on health conditions, and in this context, air pollution represents an important environmental consequence of human activities, which affects the overall $LEI$ quantity within the $HDI$ index. Indeed, in 2018, air pollution was assessed to be responsible for the deaths of around $4.5 \times 10^6$ people $yr^{-1}$ worldwide due to $PM_{2.5}$ (particulate matter measuring less than 2.5 μm in diameter, $3.0 \times 10^6$ people $yr^{-1}$), $O_3$ (ozone, $1 \times 10^6$ people $yr^{-1}$), and $NO_2$ (nitrogen dioxide, $0.5 \times 10^6$ people $yr^{-1}$). Indeed, air pollution causes diseases, and its increase is resulting in a growing cost, both for health systems and due to the climate change consequences on the economy and territories [22].

In 2013, welfare losses due to air pollution exposure accounted for [23] USD $2306 \times 10^6$ in East Asia and Pacific, USD $1245 \times 10^6$ in Europe and Central Asia, USD $604 \times 10^6$ in South Asia, USD $495 \times 10^6$ in North America, USD $194 \times 10^6$ in Latin America and the Caribbean, USD $154 \times 10^6$ in the Middle East and North Africa, and USD $114 \times 10^6$ in sub-Saharan Africa.

The health effects due to exposure to polluted air include an increased risk of stroke, heart disease, lung cancer, and chronic and acute respiratory diseases due to the carcinogenic and irritating properties of the various pollutants' components. In addition, productivity and cognitive functions must also be considered due to the loss of workforce and healthcare costs, which in 2018 accountedfor USD $2400 \times 10^6$ for adult deaths, USD $200 \times 10^6$ for disability from chronic diseases, USD $100 \times 10^6$ for sick leaves, USD $90 \times 10^6$ for preterm births, USD $50 \times 10^6$ for child deaths, and USD $17 \times 10^6$ for asthma [22].

Moreover, renewable energy was shown to represent a possible solution to reduce the country's harmful air pollution levels, mitigate climate change, and decrease energy dependence [24]. Just on these bases, in Ref. [25], the approach of incorporating external costs of air pollution from electricity generation into energy decision-making processes highlighted the need to shift from the use of fossil fuels to more sustainable and less polluting renewable energy sources, showing how a detailed quantification of external costs must be considered in well-being analyses.

Last, indirect costs can also be introduced in the analysis of other aspects, such as the quality and production (estimated at 26% in 2030) of soybean, wheat, rice, maize, and barley, because the pollutants generate toxic by-products when dissolved in water within the plants' leaves, resulting in related damage.

Thus, the reduction of the anthropogenic environmental impact is considered one of the components of a country's development level. It is well-known that environmental pollution and climate change originate from many emission sources, which present different characteristics. However, in this paper, we focus our analysis only on two main kinds of emissions, with different scale impacts: GHGs, and $PM_{2.5}$. Indeed, GHGs have a global scale effect, while $PM_{2.5}$ has a predominantly local effect. In this context, we develop an analysis in which an economic external cost associated with each pollutant is considered. Consequently, the possibility of considering their overlap is carried out to obtain an overall cost for any country. To develop an example of the application of this approach, we consider Italy as a case study. The overall cost is normalised and used together with the $HDI$ to perform an analysis that links socio-economic well-being to environmental-cost-related aspects. Thus, to verify and improve Easterlin's considerations, we compare how the perception of well-being varies with changes in $GDP$ and development indexes. Last, other parameters are also included to evaluate the Italian situation, concerning both health services and demographic indicators, and their trends over time are analysed.

## 2. Materials and Methods

Recently, in Italy, an increasing proliferation of initiatives focusing on the concept of well-being and quality of life has occurred [26–31]. To dispose a successful initiative, it is essential that the topics and quantities conveyed by it as well as the objectives to which it is calibrated reflect the collective vision of progress and well-being. In this paper, we endorse the examination of both human development and environmental cost as one of the possible conceptual frameworks for developing considerations on Italian well-being.

In this section, we introduce the methodological approach to link external costs to pollutants and well-being by considering Easterlin's approach. To do so, Section 2 is organised into three subsections, dealing, respectively, with different kinds of indicators: $HDI$, environmental costs, and well-being. Particularly, in the first subsection (Section 2.1), we summarise the methodological approach related to the $HDI$ (Human Development Index), a statistical composite index introduced by the United Nations (UN) to recognise that development should be evaluated not only by economic advances but also by improvements in human well-being. This index is used to assess the socio-economic conditions within a country. In particular, we focus our attention on Italy, here proposed as a case study. In the second subsection (Section 2.2), the Environmental Cost Index, $I_{EC}$, is proposed. It is based on the evaluation of the external costs associated with pollution, i.e., the costs not included in the market price of the goods and services being produced but related to the environmental consequences of human activities. In the last subsection (Section 2.3), we introduce a well-being score based on the outcomes of European Union (EU) surveys. The previously introduced quantities are adopted in the analysis of the Italian case study, which is developed in Section 3; in particular, after having evaluated the indicators presented in Section 2, we consider how the $HDI$ and $I_{EC}$ are related to highlight a possible relation between socio-economic improvements and environmental costs.

### *2.1. The UN's Human Development Index*

For several decades, well-being and development have been evaluated by using the gross domestic product ($GDP$) [27]. Recently, its strictly economic framework has been questioned, highlighting that economic growth represents the objective of economic policies to enhance the well-being levels in a country. Consequently, other indexes have been introduced to measure countries' status concerning socio-economic conditions and well-being [27]. One of these indexes is the the Human Development Index ($HDI$), which is an indicator to measure the developing level of a country concerning education, health, and salary conditions [15]. Indeed, economic development should measure the quality of growth, rather than just an increase in incomes, and $HDI$ can combine the advantages of the $GDP$ measure with the economic and social aspects that the $GDP$ misses [27]. In particular, the $HDI$ measures three factors rather than just income, giving a more rounded view of living standards than the $GDP$; indeed, it considers health, education, and income, which are pivotal to satisfactory living standards. Moreover, the required data to calculate it are sufficiently easy to be collected, and the adoption of purchasing power parity (PPP) can qualify income in terms of living costs. Moreover, the $HDI$ can give an idea about future living standards, i.e., education and life expectancy also are indicators of the future situation. Lastly, $HDI$ values result in a range between 0 and 1, which allows us to easily compare behaviours among different countries. On the other hand, the $HDI$ presents some disadvantages, which can be summarised as follows: (i) living standards are based around normative economics, so the $HDI$ is ultimately undermined; (ii) the $HDI$ does not provide information on inequality: income and access to educational and health services might be high amongst a small group of people but low amongst others; (iii) purchasing power parity (PPP) values can vary sharply and may be inaccurate; (iv) the years of schooling are unreliable if students are repeating years due to lack of progress; moreover, also, the level of education acquired is important, which is not included within the $HDI$ structure; (v) few countries present actual values higher than the set goalposts, making them outliers in a certain aspect and excluding them without raising their $HDI$ value; (vi) the simplified indicators used to calculate the $HDI$ components are an advantage of this index but also its weakness, because specific aspects such as crime rates, quality of the environment, political freedom, and war, etc. are not considered.

Despite these disadvantages, in this paper, we use the $HDI$ as one of the effective indexes to carry out our study, even if well-being is a topic from complex systems analysis; the use of a simple indicator allows us to avoid misinterpretations caused by deep but incomplete advanced models, being aware that our approach is affected by the limits of the index itself.

The $HDI$ is evaluated as the geometric mean of three normalised indexes representative of each above-mentioned socio-economic dimension [32,33]:

$$HDI = (LEI \cdot EI \cdot II)^{1/3} \tag{1}$$

where $LEI$ is the Life Expectancy Index, $EI$ is the Education Index, and $II$ is the Income Index. The Life Expectancy Index, $LEI$, is defined as [33,34]

$$LEI = \frac{LE - 20}{85 - 20} \tag{2}$$

where $LE$ is the life expectancy at birth, which indicates the overall mortality level of a given population. It corresponds to the years that a newborn is expected to live at current mortality rates [35]. Therefore, in order to normalise the life expectancy at birth, the UN set its minimum and maximum values to 20 and 85 years, respectively [33]. Indeed, in the XXI century, there are no countries with a life expectancy at birth lower than 20 years, and, on the other hand, the value of 85 years is set as a realistic aspirational target [33].

The Education Index, $EI$, is defined as [33]

$$EI = \frac{MYSI + EYSI}{2} \tag{3}$$

where $MYSI = MYS/15$ is the Mean Years of Schooling Index and $EYSI = ESI/18$ is the Expected Years of Schooling Index [33].

The normalised Income Index, $II$, is defined by the United Nations as follows [36]:

$$II = \frac{\ln(GNI_{pc}/100)}{\ln(75000/100)} \tag{4}$$

where $GNI_{pc}$ is the gross national income per capita at purchasing power parity (PPP), with minimum and maximum values set by the United Nations [33] as USD 100 and USD 75,000, respectively. The choice of USD 100 as the $GNI_{pc}$ minimum value is due to the difficulty in capturing the amount of unmeasured subsistence and nonmarket production within the official data of the economies close to the minimum [33], and while the maximum $GNI_{pc}$ value of USD 75,000 was selected as a threshold because of higher values, no significant gain has been shown in human development and well-being [33,37]. It should be highlighted that this index does not take into account the technological and related environmental impact levels of a country.

### *2.2. The Environmental Cost Index*

The proposal in this paper is to consider the $HDI$ in relation to some environmental cost impacts, with particular interest in the ones due to two main emissions players. Each primary/secondary pollutant or GHG has its own specific impact; thus, in order to combine its effects, an economic-based approach is adopted, rooted in the attribution of external costs. The latter can represent an interesting tool to support policymakers to commit countries' economic resources towards actions effective in reducing economic damages by providing monetary estimates related to the negative consequences of pollution. Indeed, external costs allow us to quantify from an economic perspective different impacts, e.g., environmental clean-ups, premature deaths, morbidity, etc. In particular, premature-death-related costs are usually estimated by the statistical value of life expectancy, which is a measure of how much each person is willing to pay for a reduction in the risk or probability of premature death; this cost is specific for each country, as it is also linked to its income level, while the external costs related to morbidity are estimated based on the number of days lived in a diseased state; for each country, the average daily wage rate is used to quantify the cost per day of illness. The Global Burden of Disease Studies represents the most relevant data source concerning mortality and morbidity due to numerous diseases, injuries, and risk factors, including air pollution [38]. Therefore, for each $i$-th pollutant it is necessary to know the following:

- The total amount (mass) emitted yearly ($m_i$), whose value is often available in national inventories.
- The external cost per unit of mass ($c_{Ext,i}$) associated with the $i$-th pollutant [39,40]. Indeed, this quantity, concerning power generation, considers the following: (i) the climate change damage costs associated with GHG emissions, (ii) the cost of treating health conditions, and (iii) the damage to the natural and built environment resulting from criteria air pollutants and nonenvironmental social costs for nonfossil electricity-generation technologies [25]. Furthermore, many studies related to external costs have been developed in the ExternE projects (mainly financed by the European Union), to assess the external costs of energy technologies. The ExternE methodology provides a framework for transforming impacts, usually expressed in different units into a common framework, i.e., their monetary values. From 1995 to 2005, some reports about this methodology were developed [39,40], while recently, the World Bank has focused its attention on air pollution costs, with particular interest in the ones associated with health damage [41].

Thus, to develop comparisons among the data of all countries, we introduce the external cost per capita for each $i$-th pollutant, defined as follows [39,40]:

$$C_{pc,i} = \frac{m_i \cdot c_{Ext,i}}{N_{hab}} \tag{5}$$

where $N_{hab}$ is the number of citizens.

From Equation (5), the related total cost for a country results as follows:

$$C_{Tot} = \sum_{i=1}^{Np} C_{pc,i} \tag{6}$$

where $Np$ is the number of pollutants considered.

The costs obtained by means of Equation (6) allow us to evaluate whether the country has improved over time in terms of external costs due to pollution. However, the country's behaviour must also be considered in the international context, regardless of improvements in the $C_{Tot}$ trends. This comparison can be effectively carried out by using per capita quantities. Furthermore, a normalisation approach in accordance with the one followed by the United Nations for some $HDI$ components ($EI$ and $LEI$) allows us to obtain normalised values in the range [0, 1], obtaining a common scale for all countries. Thus, to obtain a national measure related to the total external environmental costs in the international context, we introduce the Environmental Cost index ($I_{EC}$), defined as:

$$I_{EC} = \frac{C_{Tot,max} - C_{Tot,actual}}{C_{Tot,max} - 0} \quad (7)$$

where $C_{Tot,max}$ is the maximum cost per inhabitant in the overall panorama of all nations and over the entire time period analysed, and $C_{Tot,actual}$ is the value calculated for the country related to the analysed year. Considering the definition of the $I_{EC}$ (Equation (7)), when its value increases, it corresponds to an improvement in the environmental condition. As occurs for all indicators and indexes, the $I_{EC}$ presents some limitations, such as the following: (i) It should include all kinds of pollutants to be as exhaustive as possible, also considering, e.g., land use, water management, thermal impacts, etc. (ii) The minimum cost is considered null, but if irreversibility were considered, it should have a value: irreversibility cannot be evaluated a priori. (iii) The costs related to health damages cannot easily be identified because the direct correlation among effects and environmental changes results is difficult to evaluate.

Despite these limitations, this index remains easy to be communicated and includes the idea of possible health damage by its cost quantification, allowing us to develop considerations of the economic consequences of health and the environment.

### *2.3. Well-Being Evaluation*

In recent decades, many public and private institutions have carried out surveys related to the population's well-being. However, these surveys have rarely been carried out regularly or repeated over large periods with comparable results from year to year. Nevertheless, at the European level, the conditions reported above can be obtained from an instrument called the Eurobarometer, which is a polling instrument created to monitor the state of public opinion in the European Union. The "Standard Eurobarometer public opinion surveys" are one set of the most important surveys available [42]. These surveys have been conducted in all EU Member States since the mid-1970s. As Italy is among the EU founding members, a sample of its population has always been taken into account since the first available surveys. As concerns interviews, three different methods are adopted: face-to-face, telephone, and online surveys. Moreover, usually the survey sample consists of at least 1000 randomly selected people.

In this paper, the answers available to the following question have been considered: "On the whole, are you very satisfied, fairly satisfied, not very satisfied, or not at all satisfied with your daily life?" For each answer, a corresponding score was assigned, as represented in Figure 1.

| Interview rate | Very satisfied | Fairly satisfied | Not very satisfied | Not at all satisfied |
|---|---|---|---|---|
| Numerical value | 4 | 3 | 2 | 1 |

**Figure 1.** Score assigned to each possible answer to well-being interview questions from Ref. [42].

A final indicator was attributed to this question (named the well-being score, $WB$) by means of the weighted average of the score, using the sample response percentages. This $WB$ score is a subjective indicator, meaning that it captures judgments of overall life satisfaction or fulfilment of the sampled population [43]. In order to consider both subjective and objective measures related to human well-being, besides the results of surveys promoted by the Eurobarometer, it is useful to add them to objective data (generally available for each country), also to overcome conceptual concerns related to subjective-based measures, such as people's expectation and adaptation [44]. Thus, we propose to take into consideration both healthcare and demographic data, considering both the previous indicators and also the ones used by the European Observatory on Health Systems and Policies [45].

As regards the former, it is possible to analyse the following:

- The number of available hospital beds per 1,000,000 inhabitants. The hospital admission service has been and still is free; however, excluding serious cases, there are waiting lists that present growing waiting times during the last years. Therefore, the trend of these data becomes meaningful.
- The number of general practitioners per 1,000,000 inhabitants. These data allow us to characterise the availability of medical support. In Italy, this health service has been and currently is free.
- Pharmaceutical consumption related to antidepressants (unit-defined daily dosage per 1,000,000 inhabitants per day). The variation in this parameter can be useful to consider psychological distress. Indeed psychological health has been pointed out as a fundamental aspect when health conditions and well-being within a country are considered, as reported in Ref. [45].

Furthermore, in relation to the demographic data, we can consider the following parameters [45]:

- Total fertility rate, which is the average number of children that the women of a country would have at the end of their reproductive period if they were subject during their whole lives to the fertility rates of a given period and if they were not subject to mortality. It is expressed as children per woman.
- Natural change, which is the annual difference between births and deaths; the trend of this quantity over time is very meaningful to understand the future demography of a country.
- Number of the analysed country's emigrants (in the analysed case, this refers to Italian emigrants), which is the number of (Italian) citizens who have migrated to another country in a given year.

The indicators proposed are not intended to be exhaustive; nevertheless, they can support us in providing a picture of the trends that occur in a given country.

## 3. Results

In this section, the use of the considered indicators is shown in a case study represented by Italy. In undertaking this approach, following the usual approach developed in the literature [25,39,40], we introduce an analysis of local-impact emissions (e.g., $PM_{2.5}$), and global-impact emissions (e.g., GHG) in Italy by evaluating the economic costs related to their environmental impact, considering two possible scenarios. Then, the Human Development Index is analysed in relation to the Environmental Cost Index to highlight a relationship between the socio-economic and environmental conditions. Last, some indicators about the Italian healthcare system are taken into account due to the primary role of health in human well-being.

In this work, the Italian context is examined over 30 years (1990–2020). This time duration choice is also linked to Easterlin's statement about the paradox: it can be observed only over sufficiently long periods. Furthermore, the possibility of monitoring sufficiently long periods allows us to verify any temporal shift that may occur among the various indexes. However, it should be highlighted that the time coverage of some indicators is shorter than the selected reference period. Thus, for these indicators, the analysis was limited to the available data.

The data sources used are the official ones available: ISTAT (the Italian National Institute of Statistics), EUROSTAT (the Statistical Office of the European Union), UN (United Nations), OECD.Stat (Organisation for Economic Co-operation and Development), and World Bank data. In the next Sections we use some raw data that are also included in the Supplementary Material.

### 3.1. Pollutants Trends and Environmental Cost Index

In this section, we analyse the environmental impacts of pollution in Italy. In 2019, in Italy, air pollution (data related to $PM_{2.5}$ [45]) contributed to 4% of deaths each year. Two different emissions are here considered: greenhouse gas (GHG), which has effects on a global scale [46], and fine particulate matter ($PM_{2.5}$, measuring less than 2.5 µm in diameter), which has a predominant effect on a local scale [47]. We must point out that carbon dioxide equivalent emissions do not directly cause respiratory diseases; however, they contribute to climate and local weather changes, increasing the environmental temperature and humidity with consequences on annual air pollution deaths [48]. Primary pollution presents local characteristics, and $PM_{2.5}$ constitutes one of the most common causes of diseases.

Thus, Figure 2 shows the trends of both GHG (blue line) and $PM_{2.5}$ (orange line) emissions per capita associated with the Italian country. They are expressed in percentage terms, considering their 1990 levels as reference. Both pollutant emissions have decreased when comparing 2020 values with the 1990 ones (about −30% for GHG and −40% for $PM_{2.5}$) but with different behaviours: GHG emissions increased over 1995–2005 with their maximum value in 2005, and decreased in the subsequent years, while $PM_{2.5}$ presented a continuous decrease (−30%) until 2004, excluding the peak in 1991, a subsequent slight increase (+20%) during the 2004–2008 period, and a final 30% decrease in the period of 2008–2020.

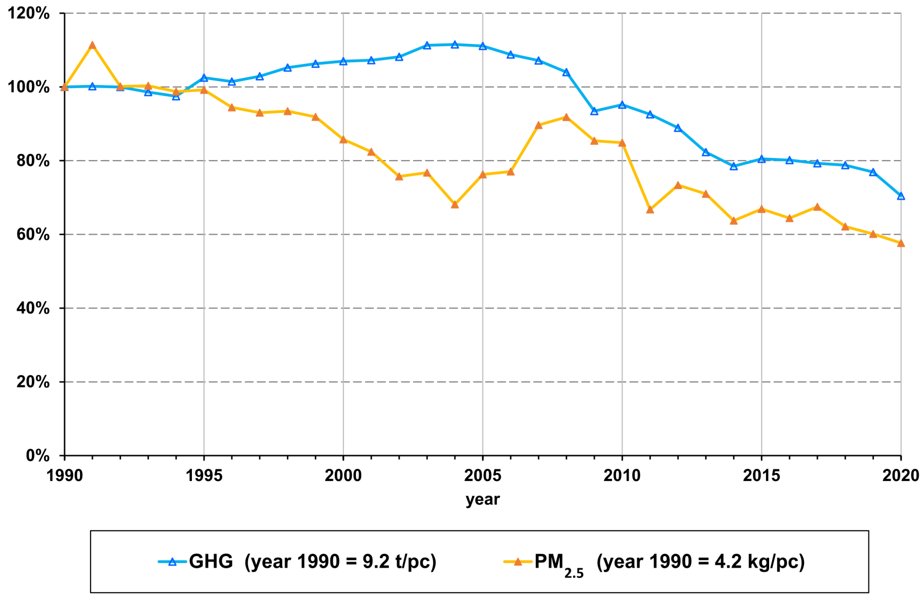


**Figure 2.** Italian GHG and $PM_{2.5}$ emissions per capita. In the graph, the 100% value is set to the emissions related to the year 1990, and its percentage variation is shown in the subsequent years. The absolute values of emissions are reported within brackets in the legend, considering 1990 as the reference year. Data collected from Refs. [46,47] and elaborated by the authors.

To consider the cumulative effect of the impacts of these two different emissions, the environmental costs are evaluated and two different scenarios are proposed in light of distinct environmental costs values.

Due to the different scale effects of these two emissions sources, distinct approaches should be adopted: concerning GHG emissions, it is possible to adopt global data from international organisations, e.g., the World Bank or the scientific literature, while the $PM_{2.5}$ costs require us to refer to the regional level because their effect is at a local scale. The two proposed scenarios can be summarised as follows:

- **Scenario L**, low environmental costs:
  - $CO_{2,eq}$ cost of damage equal to USD $40/t_{CO_2}$, in accordance with the World Bank; this value is the one adopted in the World Development Indicators context [49];
  - $PM_{2.5}$ cost equal to USD $112/kg_{PM_{2.5}}$, which is the cost associated with the Italian morbidity cost due to $PM_{2.5}$ [41] and refers to the Italian emissions of $PM_{2.5}$ [47].
- **Scenario H**, high environmental costs:
  - $CO_{2,eq}$ cost of damage equal to USD $185/t_{CO_2}$ as suggested by Rennet et al. [50], who in their work incorporated updated scientific understanding throughout all components of GHG environmental cost estimation;
  - $PM_{2.5}$ cost equal to USD $658/kg_{PM_{2.5}}$, considering the Italian costs associated with both mortality and morbidity [41].

In Figures 3 and 4, only **Scenario L** is considered to present the behaviour of GHG and $PM_{2.5}$ environmental costs and of the total environmental costs, respectively.

Thus, in Figure 3, the environmental costs related to both pollutants are shown: the total costs present a decreasing trend over time. Analysing the temporal extremes, in 1990 the cost was USD 838/pc (44% GHG and 56% $PM_{2.5}$), while in 2020 the cost dropped to USD 530/pc (49% GHG and 51% $PM_{2.5}$). Figure 3 shows a trend in agreement with the trend of the pollutants represented in Figure 2, allowing us to state that any consideration on environmental costs contemplates the pollutant emissions (environmental impact) but also assigns to them an economic interpretation, confirming that $C_{Tot}$ can be introduced for environmental analyses from an economic viewpoint. As a result of the environmental information illustrated above, it is possible to calculate the Environmental Cost Index as proposed in Equation (7). Thus, to obtain a generalised index suitable for future comparisons among countries, the maximum goalpost cost of Equation (7) is assumed to be the maximum value among the OECD countries in the 1990–2020 time period.

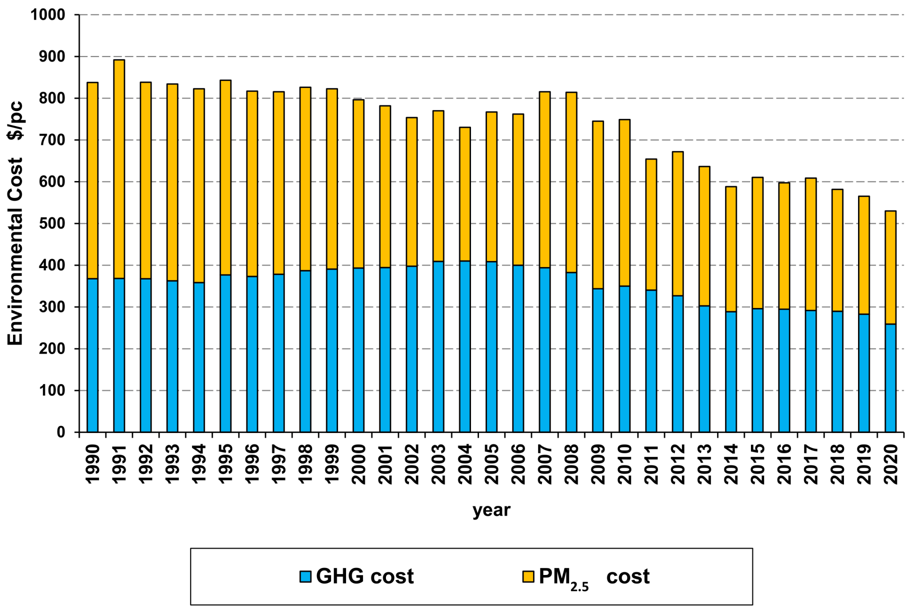


**Figure 3. Scenario L**: environmental costs of GHG and $PM_{2.5}$. Data collected from Refs. [41,46,47,49] and elaborated by the authors.

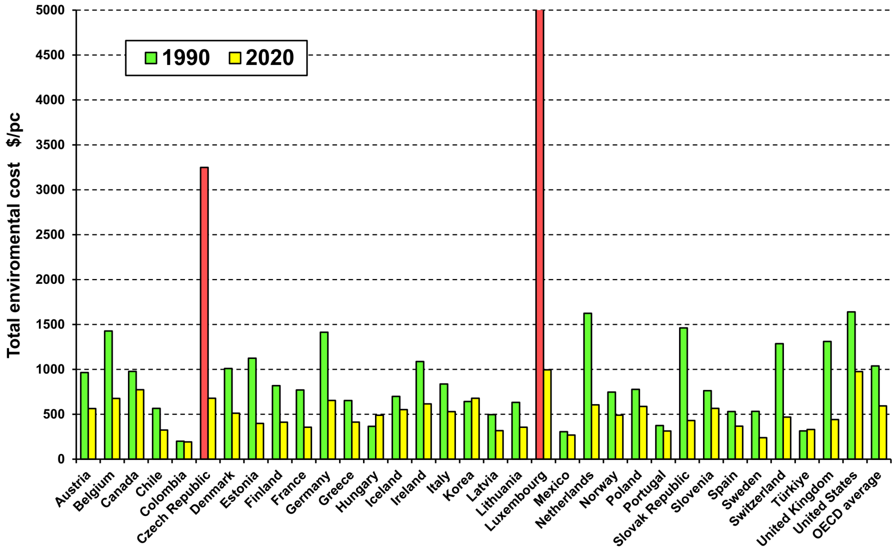


**Figure 4. Scenario L**: total environmental cost due to GHG and $PM_{2.5}$ for OECD countries in 1990 and 2020 (the outlier values are highlighted in red). Data collected from Refs. [41,46,47,49] and elaborated by the authors.

In Figure 4, the total environmental costs referring to 1990 and 2020 are shown for the OECD countries, whose average value decreases from USD 1039/pc (1990) to USD 594/pc (2020), while the Italian total environmental costs result is lower than the OECD average (from USD 837/pc to USD 530/pc, considering the same time frame). In relation to the 1990 data, two outliers can be noticed: Luxembourg and the Czech Republic. So, in the following analysis, both of these outliers as well as the countries with a lower number of citizens than the outliers themselves were excluded, and therefore the maximum goalpost values adopted in the two scenarios for Equation (7) are as follows:

- **Scenario L**: USD 1640/pc, which corresponds to the total environmental cost of the United States in 1990;
- **Scenario H**: USD 9187/pc, which corresponds to the total environmental cost of the Netherlands in 1990.

Figure 5 evidences the trends of the Environmental Cost Index ($I_{EC}$) for Italy, where the solid green line corresponds to **Scenario L** and the dotted red line represents **Scenario H**. As concerns **Scenario L**, until 2008, the Italian $I_{EC}$ index was quite stable (average value equal to 0.51), then a gradual increase was observed up to 0.65 in 2020, which corresponds to its maximum value in the time interval under examination. Italy presents a better performance in **Scenario H**, meaning that the Italian environmental total cost results are lower than the maximum goalpost set for this scenario when compared to **Scenario L**. Nevertheless, in both scenarios, an improvement in the $I_{EC}$ index emerges over time, which is clearly due to the combined effect of reductions in both GHG and $PM_{2.5}$. The GHG emission reduction is linked to several aspects, i.e., (i) an increase in energy efficiency, (ii) the wider use of natural gas compared to coal and oil, and (iii) an increase in renewable sources [51]. On the other hand, the $PM_{2.5}$ emissions reduction is mostly linked to European emissions regulations, which are reflected in the Italian ones. Indeed, during the last decades, the maximum emission factors of combustion technologies have been limited both for the road transport sector and for the civil sector (i.e., heating boilers). The $I_{EC}$ provides dual information on how a country evolves at the environmental level over time and how it ranks in relation to other countries in a given period. A limit of the $I_{EC}$ is that it corresponds to aggregate information, hiding the local impacts within it. Thus, for a more complete assessment, the disaggregated data (emissions and associated environmental costs) should always be made available, too.

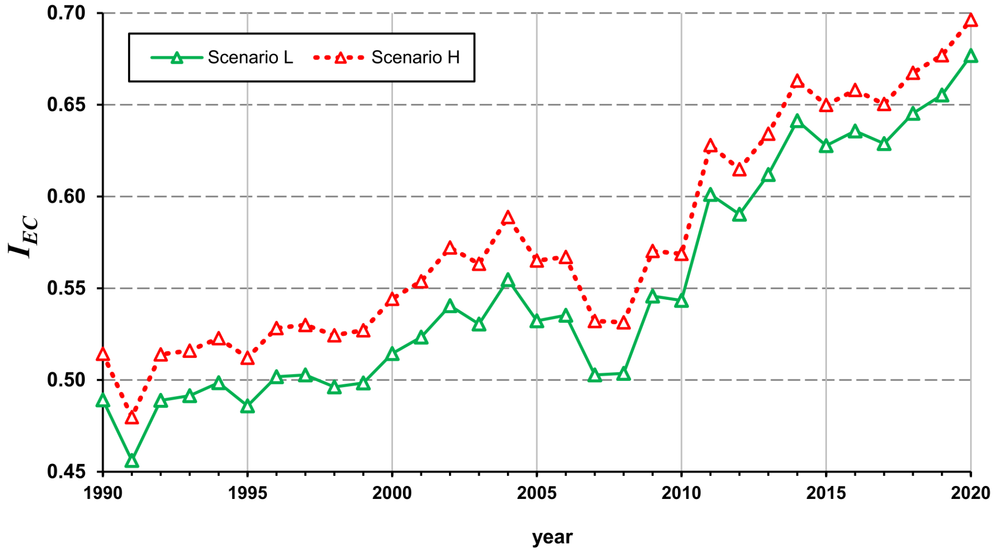


**Figure 5.** Italian Environmental Cost Index ($I_{EC}$) trends (**Scenario H** and **Scenario L**) due to GHG and $PM_{2.5}$ in the 1990-2020 time period. Data collected from Refs. [41,46,47,49,50] and elaborated by the authors.

### 3.2. Human Development Index vs. Environmental Cost Index

In Figure 6, the temporal trends of the Human Development Index components are shown for Italy.

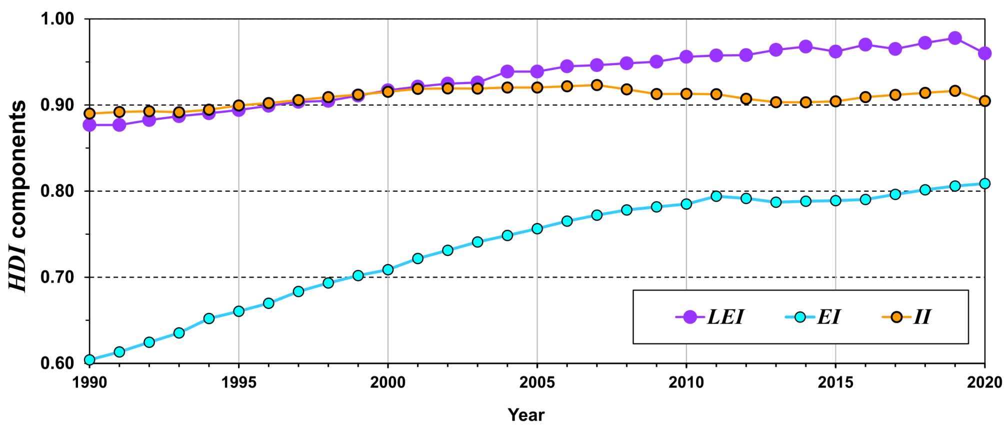


**Figure 6.** Italian trends of the $HDI$ components: $LEI$ (Life Expectancy Index), $EI$ (Education Index), and $II$ (Income Index) between 1990 and 2020. Data collected from Ref. [52] and elaborated by the authors.

The sources adopted to calculate these indexes are obtained from the United Nations (UN) statistical system [52], which in turn processes data from the Italian National Institute of Statistics and from the World Bank. For Italy, the life expectancy at birth has varied from a minimum value of 77.0 yr in 1990 to a maximum value of 83.6 yr in 2019. From these data, the $LEI$ was evaluated with Equation (2), while, as concerns the Italian Education Index, $EI$, from 1990 to 2020, the mean years of schooling increased from 7.4 yr to 10.7 yr, and the expected years of schooling increased from 12.8 yr to 16.2 yr. These data were adopted to evaluated the Education Index with Equation (3). Lastly, the Income Index was calculated with Equation (4); the economic trend behaviour is discussed later on.

The Education Index and the Life Expectancy Index show a significant increase, while the Income Index presents a slight increase until 2008, with a subsequent slight drop; however, the Income Index results are stable, around the 0.90 value.

In Figure 7, $HDI$ versus $I_{EC}$ trends related to Italy can be observed. The $HDI$ shows a progressive improving trend, starting from a value of 0.78 in 1990 and reaching a value of 0.89 in 2020. In Figure 7, the $I_{EC}$ value is calculated by the average value between the two scenarios previously described, and the horizontal bars provide the values of the $I_{EC}$ in the two scenarios (**Scenario L** and **Scenario H**).

The $I_{EC}$ index also presents an increasing trend starting from a lower value (0.49 in 1990). However, this trend is not constant; the most significant increase can be observed between 2008 and 2020 (from 0.50 to 0.68). We can highlight that even if an increase in the $HDI$ seems related to an increase in the $I_{EC}$, in some years (1991, 1995, 2004–2008, 2012) the improvement in the $HDI$ corresponded to a decrease in the environmental costs, while in 2020, an increase in the $I_{EC}$ corresponded to a decrease in the $HDI$, showing that it is possible to obtain a decrease in the environmental costs corresponding to an increase in well-being. In general, the Italian $I_{EC}$ results are constantly lower than its $HDI$ results. Consequently, future actions to improve the $I_{EC}$ will be needed. Moreover, it can be pointed out that there is no direct correlation between the two indexes, as the data related to 2010, 2013, and 2015 show; indeed, in these years, the $HDI$ assumes the same value, while the $I_{EC}$ varies significantly.

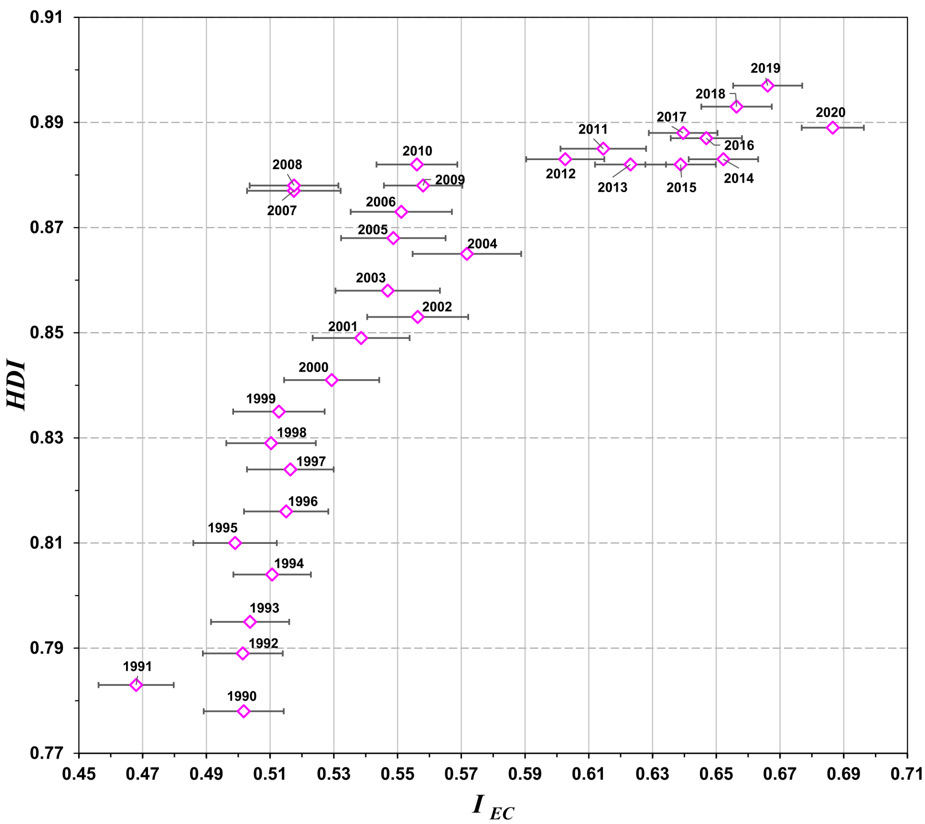


**Figure 7.** Human Development Index ($HDI$) vs. Environmental Cost Index ($I_{EC}$) over the period of 1990–2020 in Italy. The horizontal bars show the range of the $I_{EC}$ considering the **Scenario L** and **Scenario H** values.

### *3.3. Considerations on the Well-Being Score (WB)*

In this section, the trend related to well-being is compared to one of the other indexes ($GDP_{pc}$). The answers given by the sampled EU population to the Eurobarometer survey previously mentioned (Section 2) were adopted to evaluate the well-being indicator ($WB$), where the maximum score ($WB = 4$), i.e., the highest people satisfaction, is in turn associated with the maximum well-being value. Concerning Italy, the sample size of the survey was 1000 people, with an uncertainty of 3% (confidence level 95%) for the $WB$ values.

In Figure 8, the $WB$ score is considered in relation to one of the main economic indicators: $GDP$ per capita ($GDP_{pc}$).

We can highlight that the $GDP_{pc}$ has grown over the period of 1990–2007, from USD 36,586/pc to USD 45,357/pc, while the $WB$ has maintained an approximately constant value of 2.85; then, between 2007 and 2013, reductions in both $GDP_{pc}$ and $WB$ occurred, while over the period of 2013–2019, both the $GDP_{pc}$ and $WB$ showed an increasing trend. A particular case is represented by 2020 due to the SARS-CoV-2 pandemic, which caused a sharp fall in both the indicators.

In summary, the Easterlin paradox is confirmed, highlighting how long-term growth in the gross domestic product does not correspond to further growth in well-being. Other interesting considerations can be developed among the $WB$ and the $HDI$ trends (Figures 7 and 8). In Italy, during the first 15 years (1990–2005), the $HDI$ had a continuous growing trend, while the $WB$ remained stable; furthermore, in the second period (2005–2020), the $HDI$ had a slight increase with a subsequent stabilisation, while the $WB$ presented a clear reduction, with a minimum value in 2013, before returning to increase, without being able to reach pre-2005 values. It can be highlighted that the $HDI$ presents the normalised gross national income per capita ($GNI_{pc}$) as one of its components; indeed, the $HDI$ is also a function of other information (life expectancy and years of schooling), which presents a higher inertia in changing compared to the $GNI$. The result of this analysis points out that the $HDI$ is ineffective in measuring fast changes in well-being because it is affected by a significant inertia in representing brisk variations in the social perception of well-being; indeed, as it is structured, it can well represent the social and economic quantities with slow modifications over time. Thus, the individual perception results are faster than the social and economic changes. However, breaking events such as the SARS-CoV-2 pandemic can immediately affect both the socio-economic and perceived well-being indicators, as the 2020 values point out.

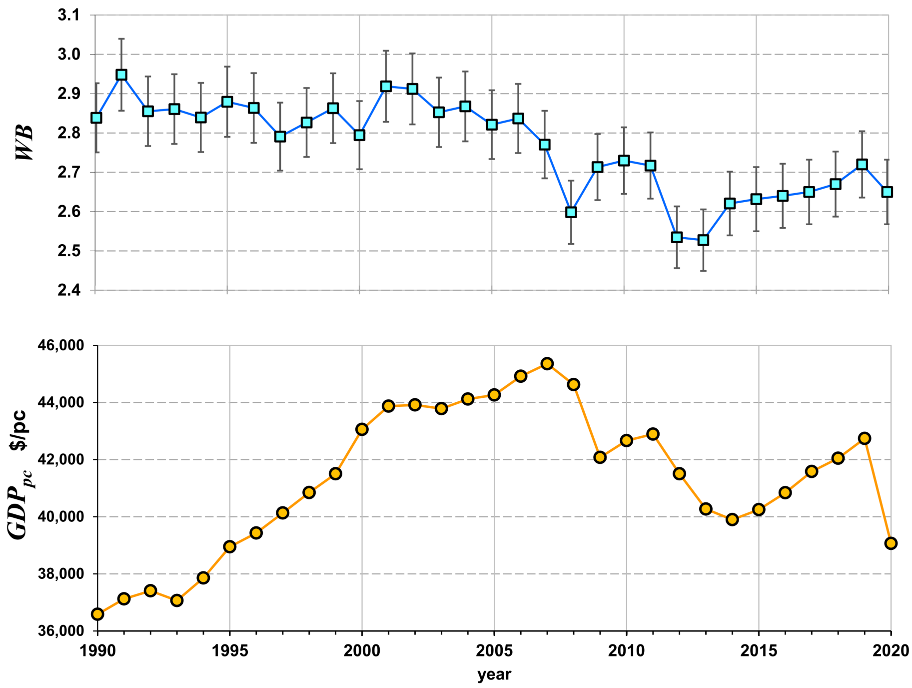


**Figure 8.** Italy temporal trend for well-being score $WB$ (based on Eurobarometer data) and gross domestic product per capita $GDP_{pc}$. Data collected from Refs. [42,53] and elaborated by the authors.

### *3.4. Further Healthcare and Demography Indicators*

Health-related and demography-related indicators represent two fundamental backbones for the objective measure of society's well-being. Thus, we develop some considerations on indicators just related to these aspects.

As regards the healthcare area, the chosen indicators are (i) the number of beds in hospitals (availability of treatment at a medical facility) [54], (ii) the number of patients/family doctors (availability of medical support at one's home) [55], and (iii) the consumption of antidepressant drugs (as an index of psychological well-being) [56–58], respectively; their trends are represented in Figure 9.

We highlight that the Italian welfare conditions related to the health system are undergoing a significant downsizing: hospital beds have been reduced by 53% in 28 years; in addition, concerning the number of general practitioners, their data show a decrease of 20% from 2000 to 2020. Finally, an increase in the consumption of antidepressant drugs can be observed (defined as daily dosage per 1,000,000 inhabitants per day); this trend should be read negatively as it indicates a growth in social hardship, in agreement with the results presented in Ref. [45], which points out that about 16.7% of Italians were estimated to have had a mental health disorder in 2019 (the same value registered by the EU average within countries). In the Italian context, anxiety disorders were the most common (over 6% of the population), followed by depressive disorders (5%, with an increase of 2.4% per year from 2017) and alcohol and drug-use disorders (2%). These considerations present the limitation caused by the $HDI$ framework; indeed, the $HDI$ does not consider the workers' conditions, so this result can be addressed only by taking into account other socio-economic conditions. However, it is possible to conjecture that independent of the cause, the use of antidepressive drugs represents a condition of a low level of well-being. In summary, all three indicators here illustrated give a worsening signal of the Italian average living conditions. Moreover, concerning the failure of planning for the actual needs of physicians and the number for patients, the present trend cannot be improved quickly. Furthermore, an increase in antidepressant drug use is observed, showing growing social hardship.

Concerning the demographic area, the selected indicators are illustrated in Figure 10 and are as follows: (i) the total fertility rate (the mean number of children a woman would have in her life) [59], (ii) the natural change (births minus deaths, thousands) [59], and (iii) the number of Italian emigrants (the number of Italians who emigrated to another country in a given year) [60], respectively.

The average value of the fertility rate in the period 1990–2020 is quite low (1.31), and in analysing its value for 2020, it is equal to 1.26, which, compared with other European countries, is one of the lowest (Italy is second-last among EU countries).

Another useful data type to evaluate in population trends is natural change: between 1990 and 2008, it was around zero, but in the following period (2009–2020), this index dropped to significant negative values ($-200{,}000$ people in 2019).

To compare this aspect between Italy and other European countries, it may be preferable to use the rate of natural change (i.e., the natural rate divided by the country's population), and for the latter, Italy is among the countries which present lower values, with an annual variation of $-3.3$ inhabitants per thousand (the European average value is $-1.2$ inhabitants per thousand).

Finally, the lower part of Figure 10 shows the migratory data of Italian citizens, which can be summarised as follows: between 2002 and 2010, the value was stable at approximately 40,000 people per year; in the following years, a sudden increase can be observed, and a peak in 2020 of approximately 120,000 people was reached. This may also be conjectured to represent a signal that a growing number of Italians cannot find adequate job opportunities or migrate due to a decline in the quality of life in Italy. In this context, it can be interesting to consider the average wages (USD, PPP converted) within the OECD countries [61]. Figure 11 shows the percentage change of wages between 2002 and 2020 (the same period considered for emigration), where Italy presents a negative value, and the same trend as in purchasing power, while the majority of OECD countries have recorded improvements.

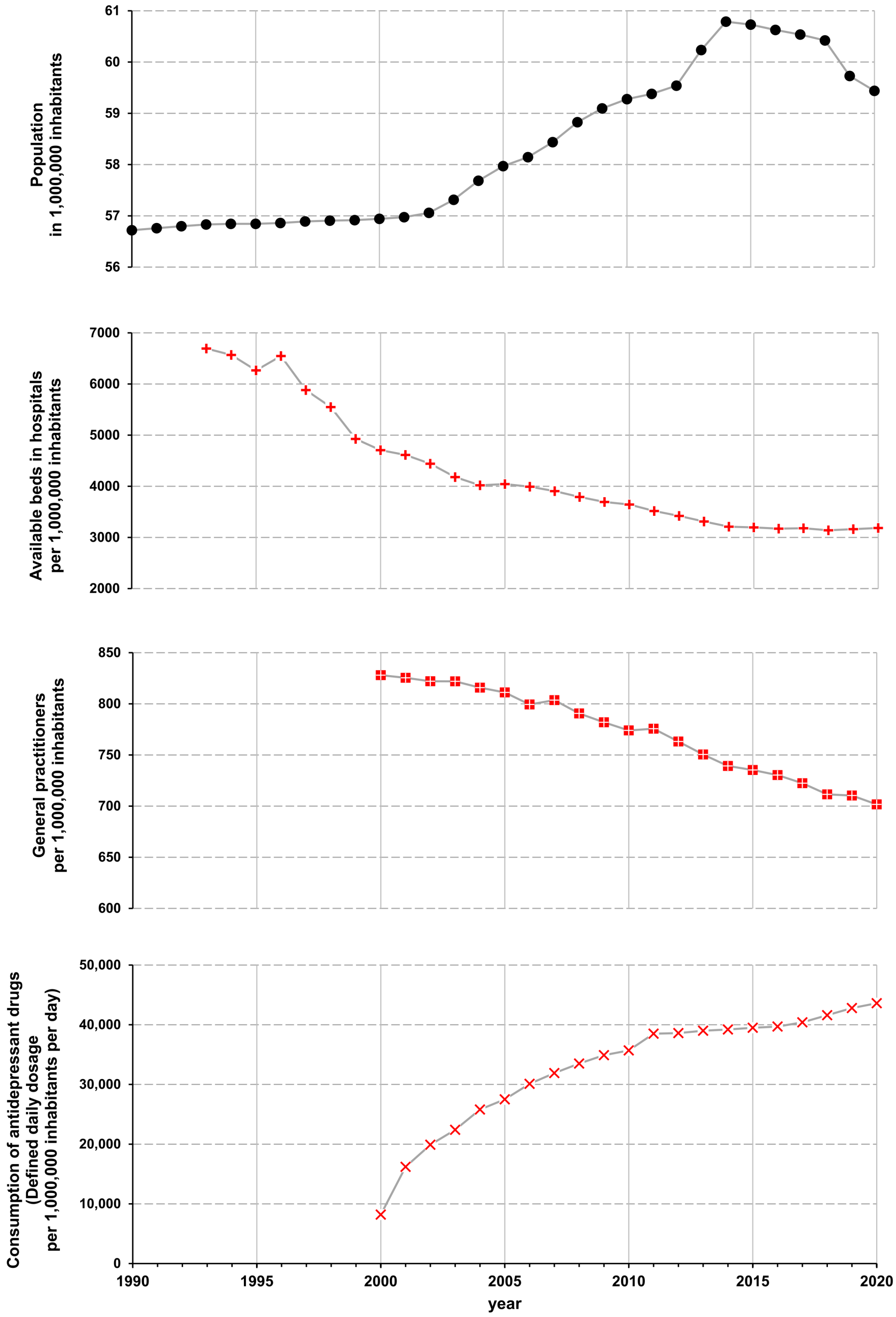


**Figure 9.** Italian temporal trend of population (black circles) and healthcare indicators (red symbols): number of beds in hospitals per million inhabitants [54], number of general practitioners per million inhabitants [55], consumption of antidepressant drugs (defined as daily dosage per 1,000,000 inhabitants per day) [54–56]. Data related to these indicators are available only for part of the time period of interest.

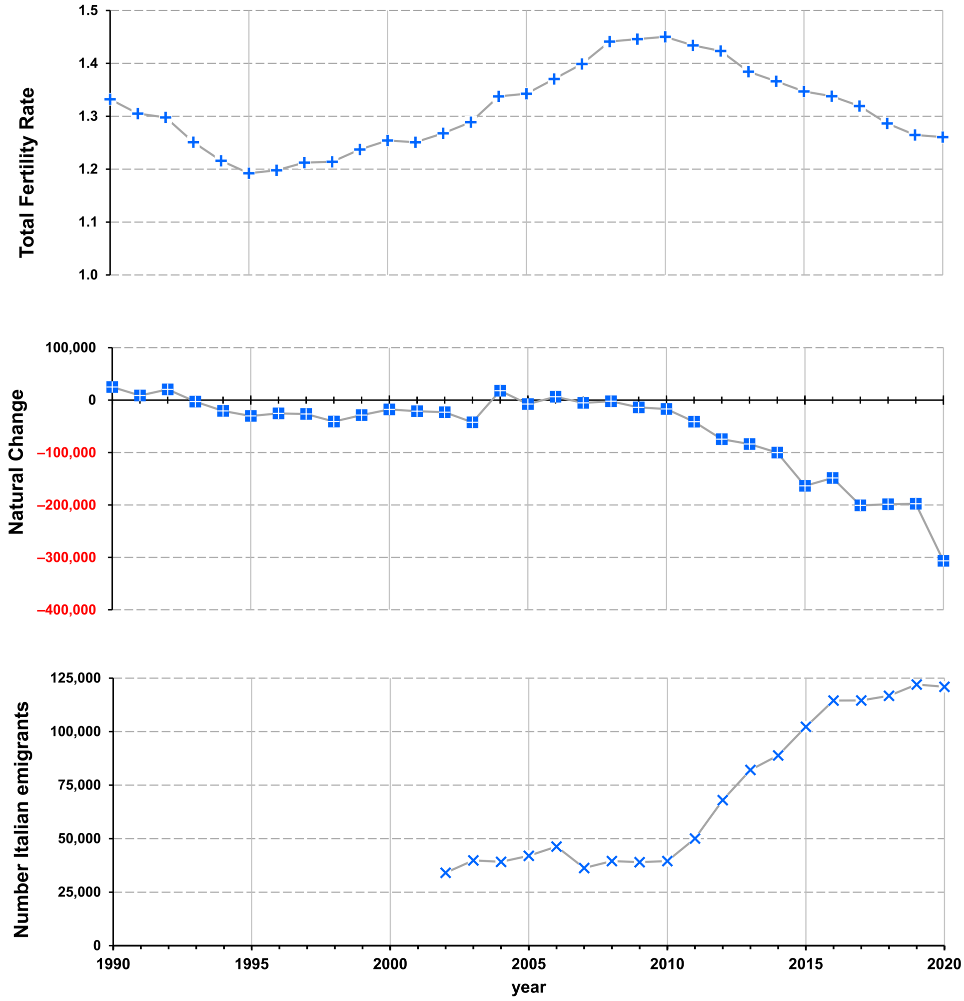


**Figure 10.** Italian temporal trend of demographic data: total fertility rate, natural change (births minus deaths) [59], number of Italian emigrants [60]. Data relating to emigrants are only available starting from 2002.

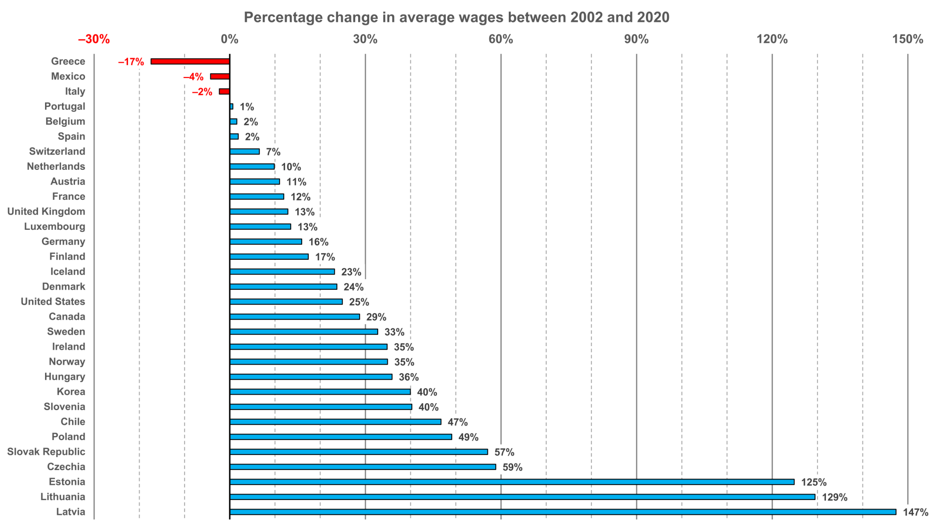


**Figure 11.** Percentage change in wages between 2002 and 2020 for some of the main OECD countries, where red bars represent negative values. Data collected from Ref. [61] and elaborated by the authors.

## 4. Discussion and Conclusions

In this paper, the Human Development Index, the environmental impact, and some well-being aspects were analysed for Italy over the last three decades. In Italy, the Human Development Index in 2020 presented the same value as in 2017 but also showed an increase in the environmental costs and a lower value than the one in 2019. Probably, this behaviour can be related to the SARS-CoV-2 pandemic. The Italian case study points out future chances to improve socio-economic and environmental conditions in Italy if some support were to be introduced in the decision-making processes.

A sustainability analysis of any country must always include environmental aspects, that, in this paper, are suggested to be evaluated by using the environmental cost. In the case of Italy, both the per capita costs associated with GHG and $PM_{2.5}$ were estimated. They present the same order of magnitude, so investments are deserved for their containment. Although the proposed analysis was limited to two pollutants, this approach allows its extension to other emissions. In general, therefore, environmental costs can be one of the components within a tool for decision makers to quantify the different environmental impacts of countries.

The approach proposed presents a perspective concerning the normalised environmental cost index for future analyses of any other country to measure its sustainability but also concerns the $WB$ score. Indeed, surveys were administered to Italian citizens to evaluate their perception of well-being, and this approach could easily be adopted in Europe, where regular forms are administered and are publicly available within the Eurobarometer platform.

The comparison between these results and the economic ones confirms the Easterlin paradox for Italy: a period of economic growth did not correspond to a significant increase in the $WB$. On the other hand, during a period of economic decline, a decrease in the $WB$ was observed.

Moreover, the well-being condition of the country was also assessed through some objective parameters. It emerged that in the last thirty years, some Italian health services have suffered heavy cuts, and the trends in demographic indexes are all negative: decline in population and fertility, increase in emigration. These indicators show a country with some structural critical issues, but unfortunately, despite more warnings on these issues, no reforms or structural political choices are observed to reverse these negative trends. Therefore, Italy, despite having reached a good level of development in light of its $HDI$ value, still has to improve its efforts regarding the environmental side and supporting well-being.

In this paper, for a comprehensive understanding of the well-being state of a country, we suggest that indexes such as the $HDI$ should always be evaluated together with environmental and well-being indicators. A further future development of the $I_{EC}$ could be expanding the information to other environmental-impacting agents, such as the addition of more air pollutants (e.g., ozone, volatile organic compounds, nitrogen oxides, etc.); moreover, for a wider global vision, other environmental aspects could also be included (e.g., water pollution, land consumption, use of pesticides, etc.). However, a limit of using aggregate indexes such as the $HDI$ and $I_{EC}$ still remains, being linked to their intrinsic loss of information. For example, the stability over time of a composite index value could hide a clear worsening of a component if it is compensated for by an improvement in another component. Therefore, for decision makers, it is important to know the overall rank of their country but also to analyse the trends of the various components that have contributed to rank it at that position. Thus, the limits of our results are represented by the same methodological $HDI$ limits, previously summarised in Section 2.1. Moreover, another limit is related to the use of subjective data obtained from public surveys. Indeed, employing surveys to collect data is an excellent way to gather lots of information from many people while being relatively cost-effective, but as highlighted in Section 2.3, the perceived well-being can lead to issues related to people's expectation and adaptation;

indeed, people from different cultural and social contexts may answer a survey in different ways, showing that the answer is related to multifaceted individual perceptions.

Despite these limits, our approach is a first attempt to obtain information on the well-being level in Italy, representing a possible starting point to highlight scenarios from which actions may be designed towards the growth of Italian well-being.

**Supplementary Materials:** The following are available at https://www.mdpi.com/article/10.3390/su16114380/s1, File S1: Raw data.

**Author Contributions:** Conceptualization, U.L., M.F.T., and G.G.; methodology, U.L., M.F.T., and G.G.; software, M.F.T. and G.G.; validation, U.L., M.F.T., and G.G.; formal analysis, U.L. and M.F.T.; investigation, U.L. and G.G.; resources, M.F.T.; data curation, M.F.T.; writing—original draft preparation, U.L., M.F.T., and G.G.; writing—review and editing, U.L., M.F.T., and G.G.; visualization, G.G.; supervision, U.L. and M.F.T.; project administration, U.L. and M.F.T.; funding acquisition, M.F.T. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** All data sources have been quoted along the text. In Supplementary Material all raw data have been reported, with their related data sources.

**Acknowledgments:** One of the authors (G.G.) must acknowledge the Horizon Europe project Mine.io (GA 101091885) and PNRR GeoSciencesIR (CUP I53C22000800006) team for the helpful discussions on social-related topics developed within the projects.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## Abbreviations

The following abbreviations are used in this manuscript:

| | | |
|---|---|---|
| $C_{pc}$ | Cost per capita | USD/pc |
| $c_{Ext}$ | Specific external cost | USD $kg^{-1}$ |
| $C_{Tot}$ | Total cost | USD/pc |
| $CO_2$ | Carbon dioxide | |
| $EI$ | Education Index | [-] |
| EU | European Union | |
| $GDP$ | Gross domestic product | USD |
| $GDP_{pc}$ | Gross domestic product per capita | USD/pc |
| $GHG$ | Greenhouse gas | |
| $GNI$ | Gross national income | $USD_{PPP}$ |
| $GNI_{pc}$ | Gross national income per capita | $USD_{PPP}$/pc |
| $HDI$ | Human Development Index | [-] |
| $I_{EC}$ | Environmental Cost Index | [-] |
| $II$ | Income Index | [-] |
| $LEI$ | Life Expectancy Index | [-] |
| $m$ | Mass emitted annually | t $yr^{-1}$ |
| $N_{hab}$ | Number of inhabitants | [-] |
| OECD | Organization for Economic Co-operation and Development | |
| $PM_{2.5}$ | Particulate matter measuring less than 2.5 μm (in diameter) | |
| **Scenario H** | High environmental costs scenario | |
| **Scenario L** | Low environmental costs scenario | |
| UN | United Nations | |
| $WB$ | Well-being score | [-] |

## References


1. Easterlin, R.A. Does Economic Growth Improve the Human Lot? Some Empirical Evidence. In *Nations and Households in Economic Growth*; David, P., Melvin, W., Eds.; Stanford University Press: Palo Alto, CA, USA, 1974.
2. Easterlin, R.A. Paradox Lost? *Rev. Behav. Econ.* **2017**, *4*, 311–339. https://doi.org/10.1561/105.00000068.
3. Easterlin, R.A.; O'Connor, K.J. The Easterlin Paradox. In *Handbook of Labor, Human Resources and Population Economics*; Zimmermann, K.F., Ed.; Springer: Cham, Switzerland, 2020.
4. Clark, A.E.; Frijters, P.; Shields, M.A. Relative Income, Happiness, and Utility: An Explanation for the Easterlin Paradox and Other Puzzles. *J. Econ. Lit.* **2008**, *46*, 95–144. https://doi.org/10.1257/jel.46.1.95.
5. Graham, L.; Oswald, A.J. Hedonic capital, adaptation and resilience. *J. Econ. Behav. Organ.* **2010**, *76*, 372–384. https://doi.org/10.1016/j.jebo.2010.07.003.
6. Stevenson, B.; Wolfers, J. Economic Growth and Subjective Well-Being: Reassessing the Easterlin Paradox. *Brookings Pap. Econ. Act.* **2008**, *1*, 1–87. https://doi.org/10.1353/eca.0.0001.
7. Diener, E.; Tay, L.; Oishi, S. Rising Income and the Subjective Well-Being of Nations. *J. Pers. Soc. Psychol.* **2013**, *104*, 267–276.
8. Veenhoven, R.; Vergunst, F. The Easterlin Illusion: Economic Growth Does Go with Greater Happiness. *Int. J. Happiness Dev.* **2014**, *1*, 311–342. https://doi.org/10.1504/IJHD.2014.066115.
9. Monnot, M.J. Marginal Utility and Economic Development: Intrinsic Versus Extrinsic Aspirations and Subjective Well-Being Among Chinese Employees. *Soc. Indic. Res.* **2017**, *132*, 155–185. https://doi.org/10.1007/s11205-015-1153-9.
10. Monnot, M.J.; Beehr, T.A. The Good Life Versus the "Goods Life": An Investigation of Goal Contents Theory and Employee Subjective Well-Being Across Asian Countries. *J. Happiness Stud.* **2022**, *23*, 1215–1244. https://doi.org/10.1007/s10902-021-00447.
11. Elmassah, S.; Hassanein, E.A. Can the Resource Curse for Well-Being Be Morphed into a Blessing? Investigating the Moderating Role of Environmental Quality, Governance, and Human Capital. *Sustainability* **2022**, *14*, 15053. https://doi.org/10.3390/su142215053.
12. Nissi, E.; Sarra, A. A Measure of Well-Being Across the Italian Urban Areas: An Integrated DEA-Entropy Approach. *Soc. Indic. Res.* **2018**, *136*, 1183–1209. https://doi.org/10.1007/s11205-016-1535-7.
13. Sagar, A.D.; Najam, A. The human development index: A critical review. *Ecol. Econ.* **1998**, *25*, 249–264. https://doi.org/10.1016/S0921-8009(97)00168-7.
14. Marinello, V.; Puma, C.D. The Human Development Index: A critical evaluation and a new proposal. *Riv. Ital. Econ. Demogr. Stat.* **2020**, *74*, 29–38.
15. Javaid, A.; Akbar, A.; Nawaz, S. A Review on Human Development Index. *Pak. J. Humanit. Soc. Sci.* **2019**, *6*, 357–369.
16. Brulé, G. Evaluation of Existing Indexes of Sustainable Well-Being and Propositions for Improvement. *Sustainability* **2022**, *14*, 1027. https://doi.org/10.3390/su14021027.
17. Jiang, L.; Cheng, Y.; Liang, W.; Zhang, B. Convergence Analysis of Cross-Province Human Well-Being in China: A Spatiotemporal Perspective. *Int. J. Environ. Res. Public Health* **2023**, *20*, 1858. https://doi.org/10.3390/ijerph20031858.
18. Wang, J.; Tang, D. Air Pollution, Environmental Protection Tax and Well-Being. *Int. J. Environ. Res. Public Health* **2023**, *20*, 2599. https://doi.org/10.3390/ijerph20032599.
19. LaBelle, M.C.; Tóth, G.; Szép, T. Not Fit for 55: Prioritizing Human Well-Being in Residential Energy Consumption in the European Union. *Energies* **2022**, *15*, 6687. https://doi.org/10.3390/en15186687.
20. Grisolia, G.; Fino, D.; Lucia, U. The education index in the context of sustainability: Thermo-economic considerations. *Front. Phys.* **2022**, *10*, 968033. https://doi.org/10.3389/fphy.2022.968033.
21. Grisolia, G.; Lucia, U.; Torchio, M.F. Sustainable Development and Workers Ability: Considerations on the Education Index in the Human Development Index. *Sustainability* **2022**, *14*, 8372. https://doi.org/10.3390/su14148372.
22. Centre for Research on Energy and Clean Air. Quantifying the Economic Costs of Air Pollution from Fossil Fuels. 2020. Available online: https://energyandcleanair.org/publication/quantifying-the-economic-costs-of-air-pollution-from-fossil-fuels/ (accessed on 8 March 2024).
23. The World Bank; IHME (Institute for Health Metrics and Evaluation). The Cost of Air Pollution: Strengthening the Economic Case for Action. 2016. Available online: https://documents1.worldbank.org/curated/en/781521473177013155/pdf/108141-REVISED-Cost-of-PollutionWebCORRECTEDfile.pdf (accessed on 8 March 2024)
24. Grisolia, G.; Fino, D.; Lucia, U. Thermodynamic optimisation of the biofuel production based on mutualism. *Energy Rep.* **2020**, *6*, 1561–1571. https://doi.org/10.1016/j.egyr.2020.06.014.
25. Dettner, F.; Blohm, M. External cost of air pollution from energy generation in Morocco. *Renew. Sustain. Energy Transit.* **2021**, *1*, 100002. https://doi.org/10.1016/j.rset.2021.100002.
26. Ferrara, A.R.; Nisticò, R. Well-Being Indicators and Convergence Across Italian Regions. *Appl. Res. Qual. Life* **2013**, *8*, 15–44. https://doi.org/10.1007/s11482-012-9180-z.
27. Burchi, F.; Gnesi, C. A review of the literature on well-being in Italy: A Human Development Perspective. In *Collana del Dipartimento di Economia, Working Paper 175*; De Filippis, F., Giunta, A., Lazzara, P., Mastroeni, L., Terzi, S., Eds.; Dipartimento di Economia Università degli Studi Roma Tre: Rome, Italy, 2013.
28. Salvati, L.; Carlucci, M. A composite index of sustainable development at the local scale: Italy as a case study. *Ecol. Indic.* **2014**, *43*, 162–171. https://doi.org/10.1016/j.ecolind.2014.02.021.
29. Haller, A.P. Italy-Economic Growth and Human Development. Comparative Analysis. *Procedia Econ. Financ.* **2014**, *15*, 916–925. https://doi.org/10.1016/S2212-5671(14)00556-5.

30. Sarra, A.; Nissi, E. A Spatial Composite Indicator for Human and Ecosystem Well-Being in the Italian Urban Areas. *Soc. Indic. Res.* **2020**, *148*, 353–377. https://doi.org/10.1007/s11205-019-02203-y.
31. Bacchini, F.; Baldazzi, B.; Biagio, L.D. The evolution of composite indices of well-being: An application to Italy. *Ecol. Indic.* **2020**, *117*, 106603. https://doi.org/10.1016/j.ecolind.2020.106603.
32. UNDP Human Development Report Office. *Concept and Measurement of Human Development*; Human Development Report 1990; UNDP (United Nations Development Programme): New York, NY, USA, 1990.
33. United Nations Development Program. *Calculating the Human Development Indices—Graphical Presentation*; Technical Notes hdr; United Nations: New York, NY, USA, 2020.
34. UNDP Human Development Report Office. *Training Material for Producing National Human Development Reports*; Occasional Paper; UNDP: New York, NY, USA, 2015.
35. World Bank Group. Life Expectancy at Birth, Total (Years). 2021. Available online: https://data.worldbank.org/indicator/SP.DYN.LE00.IN (accessed on 17 March 2021).
36. Pinar, M.; Stengos, T.; Topaloglou, N. Testing for the implicit weights of the dimensions of the Human Development Index using stochastic dominance. *Econ. Lett.* **2017**, *161*, 38–42. https://doi.org/10.1016/j.econlet.2017.09.023.
37. Kahneman, D.; Deaton, A. High Income Improves Evaluation of Life But Not Emotional Well-being. *Proc. Natl. Acad. Sci. USA* **2014**, *107*, 16489–16493.
38. GBD 2019 Risk Factors Collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *Lancet* **2020**, *396*, 1223–1249. https://doi.org/10.1016/S0140-6736(20)30752-2.
39. European Commission and Directorate-General for Research and Innovation. *ExternE—Externalities of Energy. Volume 2, Methodology*; EU Publications Office: Brussels, Belgium, 1995.
40. European Commission and Directorate-General for Research and Innovation. *ExternE—Externalities of Energy—Methodology 2005 Update*; Bickel, P., Friedrich, R., Eds.; EU Publications Office: Brussels, Belgium, 2005.
41. The World Bank. *The Global Health Cost of $PM_{2.5}$ Air Pollution A Case for Action Beyond 2021*; The World Bank: Washington, DC, USA, 2022.
42. European Commission. European Commission Standard Eurobarometer Series from 1975 to 2022 Technical Reports. 2023. Available online: https://europa.eu/eurobarometer/surveys/browse/all (accessed on 19 September 2023).
43. Azizan, N.H.; Mahmud, Z.; Rambli, A. Measurement Instrument and Indicators of Subjective Well-Being: A Review Paper. *J. Asian Behav. Stud.* **2018**, *3*, 22–33. https://doi.org/10.21834/jabs.v3i11.322.
44. Dolan, P.; Metcalfe, R. Measuring Subjective Wellbeing: Recommendations on Measures for use by National Governments. *J. Soc. Policy* **2012**, *41*, 409–427. https://doi.org/10.1017/s0047279411000833.
45. European Commission. *State of Health in the EU—Italy Country Health Profile 2023*; The Country Health Profile Series; European Observatory on Health Services and Policies: Brussels, Belgium, 2023.
46. OECD. OECD Environment Database—Greenhouse Gas Emissions. 2024. Available online: https://stats.oecd.org/Index.aspx?DataSetCode=air_ghg# (accessed on 28 February 2024).
47. OECD. OECD Environment Database—Emissions of Air Pollutants: Particulate ($PM_{2.5}$). 2023. Available online: https://stats.oecd.org/Index.aspx?DataSetCode=AIR_EMISSIONS (accessed on 22 September 2023).
48. Andersen, Z.J.; Vicedo-Cabrera, A.M.; Hoffmann, B.; Melén, E. Climate change and respiratory disease: Clinical guidance for healthcare professionals. *Breathe* **2023**, *19*, 220222. https://doi.org/10.1183/20734735.0222-2022.
49. The World Bank. Appendix A: Summary of methodology and data sources. In *The Changing Wealth of Nations 2021* ; The World Bank: Washington, DC, USA, 2021.
50. Rennert, K.; Errickson, F.; Prest, B.C.; Rennels, L.; Newell, R.G.; Pizer, W.; Kingdon, C.; Wingenroth, J.; Cooke, R.; Parthum, B.; et al. Comprehensive evidence implies a higher social cost of $CO_2$. *Nature* **2022**, *610*, 687–692. https://doi.org/10.1038/s41586-022-05224-9.
51. IEA (International Energy Agency). Energy Statistics Data Browser. 2024. Available online: https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser?country=ITALY&fuel=CO2%20emissions&indicator=CO2BySource (accessed on 26 April 2024).
52. Human Development Report Office (HDRO). 2023. Table 1: Human Development Index and Components. Available online: https://hdr.undp.org/data-center/documentation-and-downloads (accessed on 27 September 2023).
53. World Bank Group. World Gross Domestic Product. 2023. Available online: https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.MKTP.PP.KD&country=# (accessed on 5 June 2023).
54. EUROSTAT. EUROSTAT Available Beds in Hospitals by NUTS 2 Region. Italy Data. 2023. Available online: https://ec.europa.eu/eurostat/databrowser/view/hlth_rs_bdsrg/default/table?lang=en (accessed on 12 September 2023).
55. EUROSTAT. EUROSTAT Physicians by Category: Generalist Medical Practitioners. Italy Data. 2023. Available online: https://doi.org/10.2908/HLTH_RS_PHYSCAT (accessed on 12 July 2023).
56. Italian Medicines Agency. *The Medicines Utilization Monitoring Centre. National Report on Medicine Use in Italy*; Italian Medicines Agency: Rome, Italy, 2007.
57. Italian Medicines Agency. *The Medicines Utilization Monitoring Centre. National Report on Medicine Use in Italy*; Italian Medicines Agency: Rome, Italy, 2015.
58. Italian Medicines Agency. *The Medicines Utilisation Monitoring Centre. National Report on Medicines Use in Italy*; Italian Medicines Agency: Rome, Italy, 2022.

59. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2022 Revision. 2022. Available online: https://population.un.org/wpp/ (accessed on 21 January 2024).
60. ISTAT (Italian National Institute of Statistics). Iscrizioni e Cancellazioni All'anagrafe per Trasferimento di Residenza. 2023. Available online: http://dati.istat.it/ (accessed on 4 February 2024).
61. OECD. OECD Labour Dataset: Average Annual Wages. 2023. Available online: https://stats.oecd.org/Index.aspx?DataSetCode=AV_AN_WAGE# (accessed on 14 May 2024).