Article

Walking Together Indicator (WTI): Understanding and Measuring World Inequality

Salvatore Flavio Pileggi [ID]

School of Computer Science, Faculty of Engineering and IT, University of Technology Sydney,
Ultimo, NSW 2007, Australia; salvatoreflavio.pileggi@uts.edu.au

Abstract: Socio-economic inequality may be addressed at a different scale. Its impact at a micro and macro level on very many social issues is well-known, as well as its effects on global development being extensively reported in literature, where inequality is often seen as a clear barrier on the path to a sustainable development. That becomes extremely critical in light of major global challenges, such as climate change. The quantification of inequality in the different contexts, its interpretation, as well as its impact on society at a different level are object of major interest and discussion within the scientific community. Inspired by the famous African proverb "if you want to go fast go alone; If you want to go far go together", we propose an indicator—*Walking Together Indicator (WTI)*, based on a simple model to foster transparency and broad communication. It relies on the statistical standard deviation to facilitate the measurement of inequality looking at single metrics (e.g., GDP) as well as considering broad categories (e.g., Economy) composed of multiple indicators. Despite evident limitations, simplifications (context-less comparison among countries) and approximations (significant lack of data), the study conducted on well-known macro indicators presents a fundamental coherence in the result. Indeed, it shows a reducing inequality in the main trends. On the other side, the performed computations also point out a relevant exception for the main economic indicator, which is characterised, overall, by an increasing inequality among the considered countries. Such a contrasting trend is partially explainable looking at the simplifications in the model, which neither considers dependencies among indicators nor assumes weighting. The indicator provides a very encouraging and optimistic figure. However, the recent pandemic has shown a world running at different speeds. It advises a more conservative interpretation of the indicator as the exception related to economy is relevant.

Keywords: socio-economic inequality; global indicators; global development; sustainable development; socio-economic indicators

1. Introduction

Socio-economic inequality may be understood at a different scale as, in general terms, it can exist both within and between countries. Socio-economic inequality is addressed, directly or indirectly, in a variety of contexts and disciplines to assess its relationship with the different aspects of life.

For instance, there is consistent worldwide evidence that people at a socio-economic disadvantage suffer a heavier burden of illness and have higher mortality rates than their better-off counterparts [1]. Additionally, there is a clear impact at a more generic level, where such inequalities create a system in which people in power can very easily dominate and take advantage of those without power [2]. Last but not least, the relationship between economy and inequalities is the object of continuous research as even recent studies clearly show [3].

Many wicked problems are caused or significantly fostered by inequalities. For example, one of the most serious contemporary effects of inequalities between and within nations is the phenomenon of global sex trade or human trafficking for the purposes of sex [2].

Looking holistically at global development challenges [4] as well as at sustainable development, defined broadly as "an attempt to combine growing concerns about a range of environmental issues with socio-economic issues" [5], socio-economic inequality is currently seen as a clear barrier on the path of sustainable development [6]. In a VUCA [7] world—i.e., in a context characterised by volatility, uncertainty, complexity and ambiguity—contrasting the growing inequality is considered a priority [8].

The quantification of inequality in the different contexts is also a classic topic of major interest [9]. For instance, the Gini index is a summary statistic that measures how equitably a resource is distributed in a population, with income as a primary example [10].

In light of the current socio-economic and environmental challenges, the capability to measure inequality in the different contexts may play a significant role as indicators are often used to enhance and foster evidence-based strategies. At a more holistic level, it may facilitate a more consistent analysis and interpretation. Due to the intrinsic complexity of inequality at a socio-economic level, a heterogeneous approach to define indicators by combining different aspects is probably more effective at expressing real trends as it reflects the existing trade-offs. Inspired by the famous African proverb "if you want to go fast go alone; If you want to go far go together", we propose an indicator, *Walking Together Indicator (WTI)*, based on a simple model to facilitate transparency and broad communication. It relies on the statistical standard deviation to facilitate the measurement of inequality looking at single metrics (e.g., GDP) as well as at categories including multiple metrics (e.g., Economy).

The proposed indicator may be applied at a different level of granularity, normally depending on the size of the considered regions (e.g., countries or continents). Such regions may be identified either on the basis of geographic (e.g., Balkan countries) or political (e.g., countries) criteria. In this study, we address an abstracted view by country. As discussed later on in the paper, this focus implies some approximation and inaccuracy, due mostly to lack of data. However, despite not taking into account inequality within countries, it allows a relatively in-depth analysis maintaining, at the same time, a holistic focus. On the other side, the major limitation of the approach proposed is related to the lack of context, as countries are considered equally without considering any contextual factor, such as the population. However, non-compensatory aggregations are often used in the broad context of composite social indicators [11]. We believe that, despite some possible potentially misleading result, this approach provides a more transparent and relatively unbiased perspective.

Similar considerations apply also to the observation time. Given the proposed method, which is based on trend analysis, and the heterogeneous nature of the input data, it would be advisable to consider a relatively long time-frame, ideally, at least the last 15–20 years.

The paper continues with related work (Section 2) and methodological aspects (Section 3). The core part of the paper is composed of two sections that discuss computations and results overview (Section 4) and discussion in context looking at the recent pandemic (Section 5). As usual, the last section provides conclusions and an overview of possible future work.

2. Related Work

The concept of inequality, as previously introduced, may be addressed from different points of view. This section provides a brief summary of the related body of knowledge with a socio-economic focus.

2.1. Socio-Economic Inequality: Well-Being and Welfare

In line with modern trends in economics, which rely on heterogeneous indicators rather than on purely economic measures [12], a holistic understanding of inequality assumes a socio-economic focus. In such an approach, income inequality and economic growth are explicitly related to a variety of social phenomena [13]. Socio-economic inequality is present at different levels in our society [13], with a clear impact on key aspects of life

(e.g., healthcare [14]), even looking at developed countries [14]. It becomes more and more critical in less developed countries [15] where, in general terms, life is intrinsically more complicated and challenging if compared with the industrialized nations.

Looking at a specific environment, typically a country, inequality may be related to the generic well-being, understood as a fundamental human goal to have our lives going well [16]. Well-being normally refers to feeling good and functioning well [16]. Research findings on the impact of income inequality to subjective well-being (i.e., life satisfaction and happiness) remain inconclusive [17], at least in general terms. It is also largely assumed that individual well-being depends on many dimensions of life [18]. However, when well-being is approached at a social level [19], the intrinsic relationship with inequality becomes somehow evident, yet complicated to quantify in an objective and generic way.

It naturally leads to welfare [20], which is conceptually different from well-being as it normally emphasises on governments' actions to improve social well-being. Indeed, inequality and welfare are considered to be intrinsically correlated [21], especially in a globalised context [22] and within less developed countries [23]. Additionally, a consistent number of studiers in literature address the nexus of inequality, welfare and poverty [21,24–26], as well as on the direct impact on healthcare [27–29].

2.2. Global Development and Sustainable Future

Looking at inequality in terms of global development implies a more holistic view that broadly addresses the idea that societies and countries have differing levels of economic or human development [30]. Such a focus points out a generic inequality rising in a global economy [31] , as well as the concept of global inequality [32]. Aiming at a sustainable future [33], the concept of sustainable global development and its goals and challenges become central. It is commonly understood as a development in which "current generations should meet their needs without compromising the ability of future generations to meet theirs" [34].The role of inequality towards a sustainable future is the object of continuous study and discussion [35,36].

2.3. Income Inequality and beyond

Most studies on inequality assumes the Gini coefficient, which is, indeed, considered the most popular method. Many studies address income inequality within a given country (e.g., [37,38]) or in a given context, such as the developing countries [39]. Such studies are extremely valuable as they allow to identify and explain complex relationships with social trends and phenomena including, among others, mental illness, violence, imprisonment, lack of trust, drug abuse and poor educational performance [40]. The relevance of the topic suggests a deep investigation on causes and consequences [41] as well as a need for standardization [42].

In a context of re-iteration of the importance of studies on income inequality, this work addresses a more holistic concept of socio-economic inequality resulting form a multi-criteria approach involving heterogeneous data. The target indicator wants to provide a concise measure of inequality at a socio-economic level by combining heterogeneous indicators.

3. Methodology and Approach

This section aims to provide an overview of the methodological aspects with a focus on major simplifications and limitations. Additionally, the section deals with the approximations applied as their impact on the main findings is briefly discussed.

3.1. Indicators and Categories

Looking at the construction and adoption in fact of composite indicators, the selection of single indicators plays a key role and, depending on a given intent and extent, may be object of controversy and dispute among the different stakeholders (typically policy-makers, academics, the media and other interested parties) [43].

Although there is no systematic method to identify a set of indicators that can exhaustively reflect the broad socio-economic context, a number of principles have been recently established [43]. In the context of this work, indicators have been selected in line with the following considerations/criteria:

- Input indicators are well-known, extensively discussed in literature and adopted in practice;
- Input indicators are publicly available;
- Input indicators have a clear semantic. Each indicator should provide a measure of one single concrete aspect. Therefore, composite indicators are not considered;
- The number of considered indicators should be minimised to foster transparency and clarity. Indeed, a larger number of indicators does not provide necessarily more knowledge or a more exhaustive support for analysis.
- In the limits of the possible, selected indicators should have a minimum overlapping, meaning they should focus on different aspects.

From a data point of view, this study relies on the macro-indicators reported in Table 1. As shown, raw data are organised according to a soft classification in order to enable a more structured analysis and focused discussion.

Table 1. Indicators by category.

	Indicator	Source
	Economy	
E.1	*GDP x capita*	[44]
E.2	*Unemployment Rate*	[45]
E.3	*Extreme Poverty*	Computations based on [46]
	Healthcare	
H.1	*Life Expectancy*	[47]
H.2	*Hospital beds ($\times 1000$ people)*	[48]
H.3	*Children Mortality-Mortality rate, under-5 (per 1000 live births)*	[49]
	Resource	
R.1	*Military expenditure (% of GDP)*	[50]
R.2	*Government expenditure on education, total (% of GDP)*	[51]
	Violence	
V.1	*Intentional homicides (per 100,000 people)*	[52]
V.2	*Suicide mortality rate (per 100,000 population)*	[53]

Intuitively, the proposed categories may present inter-dependency and overlapping, as most indicators could be associated with more than one category. Indeed, the assessment of possible inter-dependency and overlapping from a theoretical and empirical perspective is commonly object of interest within the community (e.g., [54]).

In the specific context of this work and at a more conceptual level, the arbitrary proposed categorization does not have an actual impact on the final results as the study is designed according to a holistic approach. However, from a more practical perspective, the categorisation is absolutely relevant as the measure object of study can be provided for single indicators, as well as by category or even as a holistic measure. Therefore, the composition of each category becomes relevant. In general terms, we believe that an analysis by category supported by fine-grained measures provides an appropriate level of abstraction that should facilitate an effective and relatively smooth communication.

In summary, the proper selection of meaningful indicators and their classification does not play any role in the indicator design but, at the same time, are critical to its application. Ideally, and in line with selection criteria, the set of considered indicators should be minimal and only indicators that provide an actual added value in scope should be selected. We

believe the selected categories and indicators as in Table 1 may be considered an acceptable trade-off between exhaustiveness and availability.

3.2. Metrics

Given a set of indicators of interest measured for different regions in a certain time range, the *Walking Together Indicator (WTI)* is based on the computation of a classical statistical metric, the standard deviation (Equation (1)).

$$\sigma(i,t) = \sqrt{\frac{\sum(x_{i,c,t} - \mu_{i,\_,t})^2}{C}} \tag{1}$$

In the equation, $x_{i,c,t}$ is the value of the indicator i at time t for the region c, while C is the number of considered regions. Finally, $\mu_{i,\_,t}$ is the mean value of the indicator over the different regions at the time t.

According to the standard deviation definition, in this specific case, lower values indicate a small inequality among regions on an indicator, while larger values are associated with a more significant inequality. The ideal case (null standard deviation) corresponds to a total absence of inequality. Realistically, a positive performance assumes a declining trend of the standard deviation in the observation time.

In theory, trends are not sensitive of absolute values. However, WTI results from heterogeneous data. Therefore, in order to facilitate a homogeneous representation, WTI is computed by assuming a normalised metric (Equation (2)). There are different techniques that can be applied to normalise composite indicators (e.g., [55,56]). WTI adopts a simplified approach with values between 0 and 1.

The interpretation of the normalised indicator is completely different from the standard version as 0 is equivalent to the minimum inequality value in the considered period, while 1 is associated with the maximum inequality value observed in the same period.

$$WTI(i,t) = \sigma^N(i,t) = \frac{\sigma(i,t) - min(\sigma(i,\_))}{max(\sigma(i,\_)) - min(\sigma(i,\_))} \tag{2}$$

3.3. Approximations

Despite the adoption of a simple method applied to secondary data, a number of approximations are intrinsically needed, with an impact on the accuracy of computations.

Indeed, rather than performing computations on a selected number of countries based on data availability, we prefer to systematically compute data for all countries by considering all available data in the original datasets. Major approximations are related to missing data, meaning that not all data requested by an accurate computation are effectively available.

Missing data are related to both dimensions of analysis as the different indicators are not always available for all countries and for all time slots. In this specific case, we are pretty confident that such approximations generate a relatively minor deviation that does not alter fundamental results. The detail on specific missing data points is not provided as part of the result and associated analysis.

## 4. Understanding and Measuring World Inequality: WTI

This section presents the computation of WTI from raw data. The analysis is performed by category (Table 1) against the trends of the original indicators in the period of observation. Each sub-section addresses a specific category by providing an overview of the data underlying the computation and, then, the computational result for that category. A more generic discussion of results is proposed later on in the final part of the paper.

4.1. Economy

Economic inequality was assessed by considering three different well-known indicators as per Table 1: *GDP × capita*, *Unemployment rate* and *Extreme Poverty*—i.e., the share of population living in a given country with a very low income.

As expected, regardless of global trends, the GDP x capita points out a strong economic inequality (Figure 1a). The related WTI reported in Figure 2 clearly shows a concerning trend as such an inequality has been increasing almost constantly with lower values corresponding to the beginning of the observed period and higher values associated with the pre-pandemic period. On the other side, unemployment (Figure 1b) and extreme poverty (Figure 1c) propose an opposite trend (Figure 2), with a fundamentally declining inequality in the observed period.

The combined computation (average value) also reported in Figure 2 refers to the average value of WTI for the considered economic indicators. Assuming an equal weight for all components, in quantitative holistic terms, the economic inequality has been decreasing in the last 20 years with WTI reduced from 0.62 (2000) to 0.37 (2019).
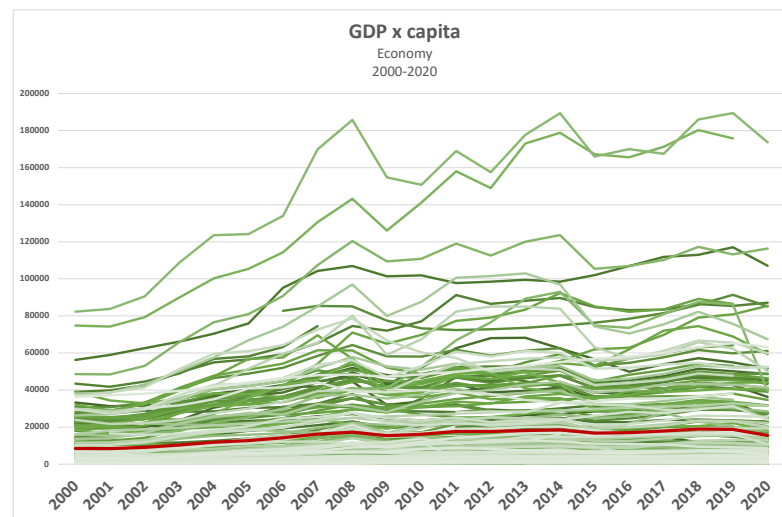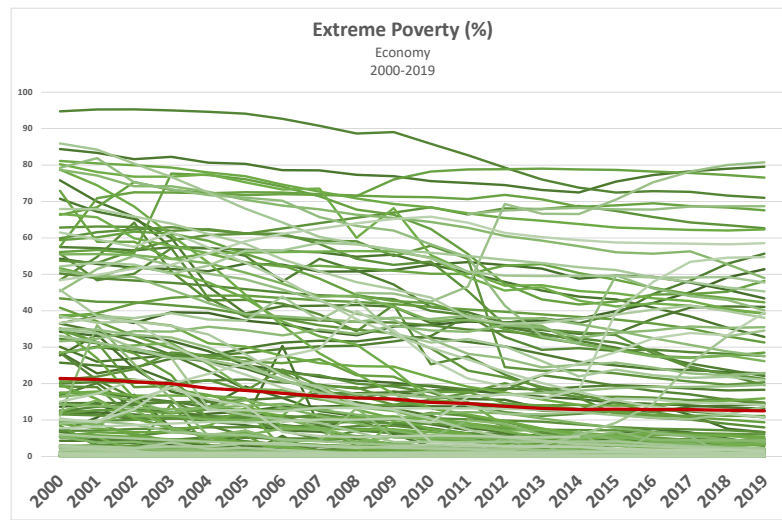

(**a**)
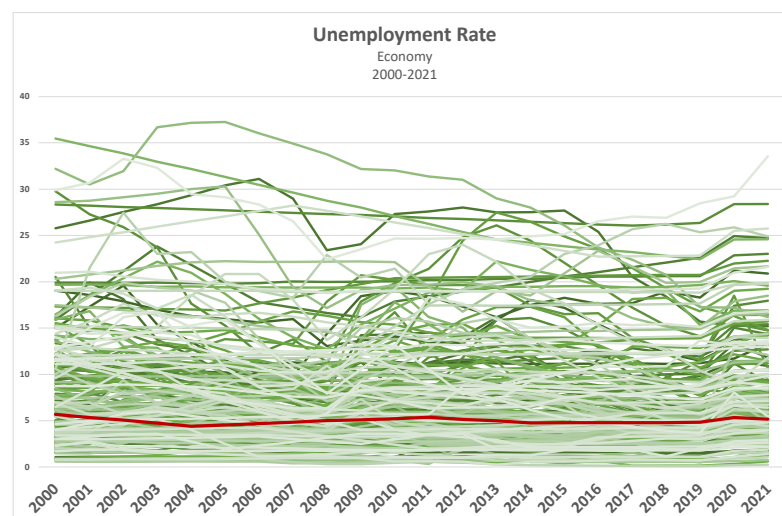
(**b**)

Figure 1. *Cont.*

(**c**)

Figure 1. Overview of the considered economic indicators. Green lines represent the values associated with single countries, while the red line shows the average value. (**a**) GDP × capita [44]; (**b**) Unemployment Rate [45]; (**c**) Extreme Poverty (computations based on [46]).
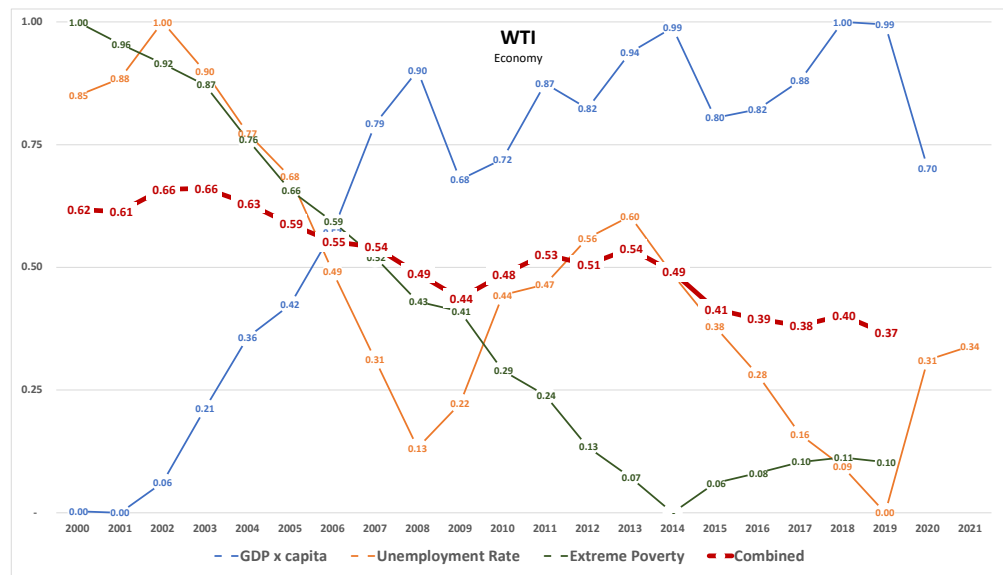

Figure 2. WTI—Economy. It results from computations on the raw data reported in Figure 1. The combined value is the average of the WTI for the different indicators.
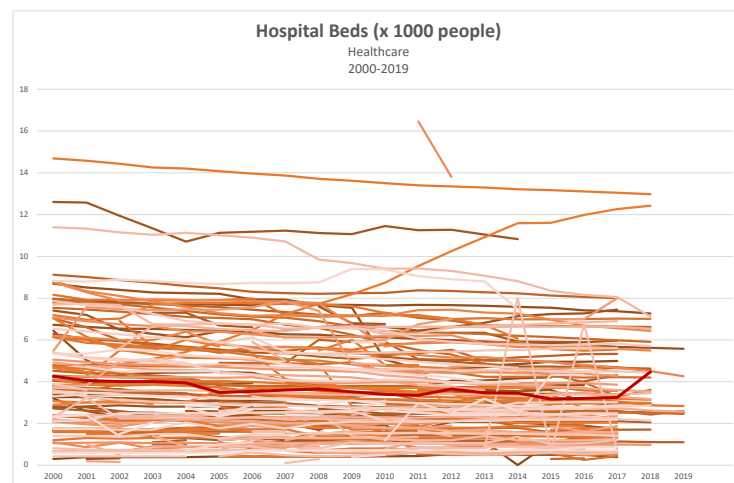
4.2. Healthcare

The healthcare category includes currently three different indicators: *Life Expectancy*, *Children Mortality* and *Hospital Beds*. While the first two indicators aim to provide a very generic assessment of healthcare in a given country in context, the number of hospital beds available pretends to measure, always in very generic terms, the capability of the healthcare infrastructure as in other studies [57]. Currently available data are reported in Figure 3a–c. Unfortunately, the indicator related to hospital beds is available for a relatively limited number of countries and presents a significant amount of missing data.

The average values show a very positive trend for life expectancy (which is increasing) and for children mortality (which is decreasing) over the period of observation. A clear assessment of the healthcare infrastructure is not possible due to missing data. However, the trend seems to be negative (less hospital beds available) until 2017 and, then, positive in 2018.
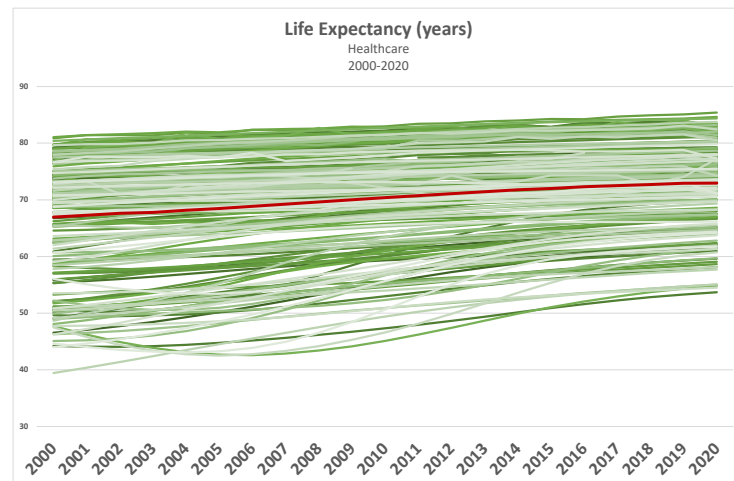
(**a**)

(**b**)
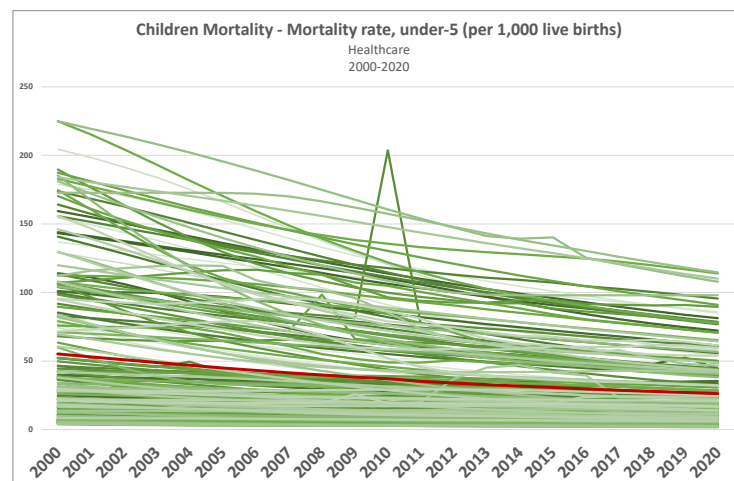
(**c**)

Figure 3. Overview of the considered healthcare indicators. Green/orange lines represent the values associated with single countries, while the red line shows the average value. (**a**) Life Expectancy [47]; (**b**) Hospital Bed [48]; (**c**) Children Mortality [49].

In terms of inequality (Figure 4), life expectancy and children mortality propose both an ideal pattern, with a progressive decrease over the period. The indicator related to hospital beds presents an unclear pattern with a mostly positive trend since 2012. Overall, the category is characterised by a decreasing level of inequality with a significant uncertainty inducted by missing data.
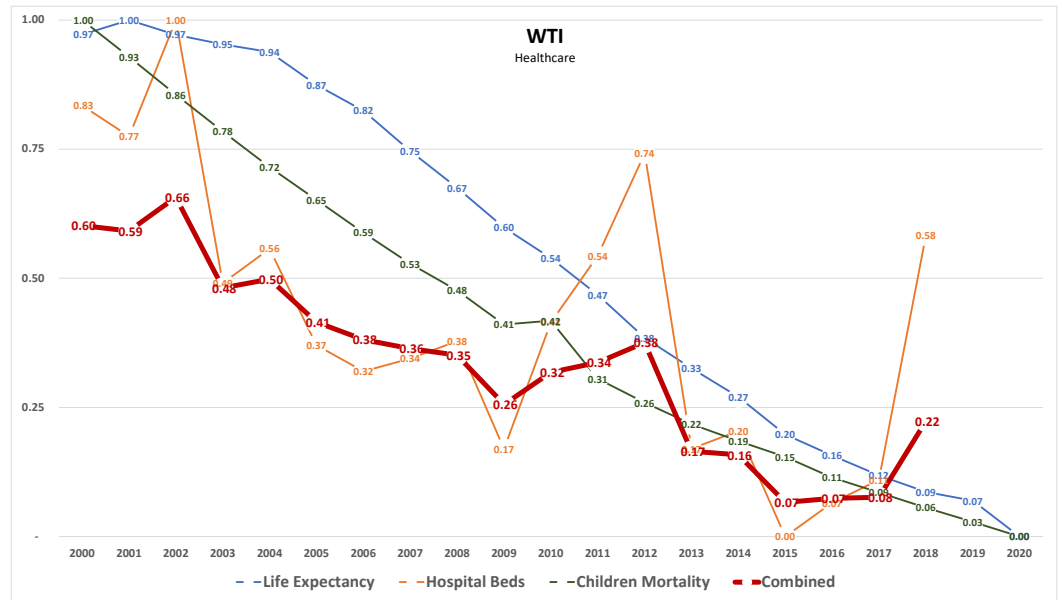

Figure 4. WTI—Healthcare. It results from computations on the raw data reported in Figure 3. The combined value is the average of the WTI for the different indicators.
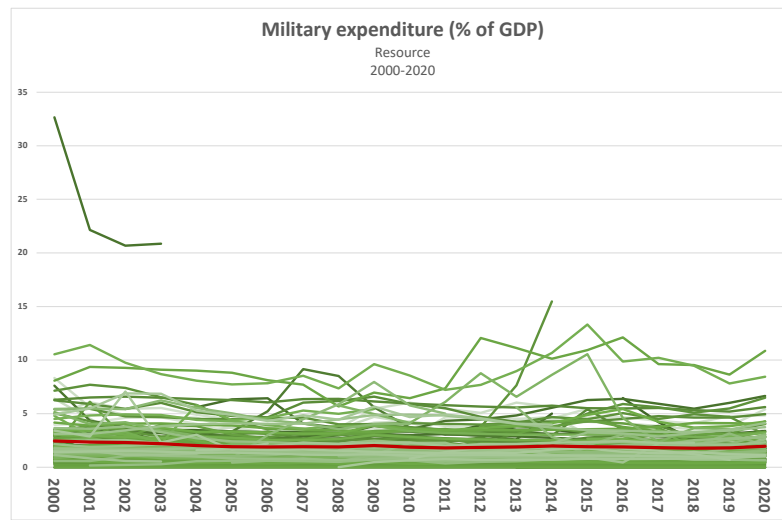
4.3. Resource

Under the resource category, we consider indicators that aim at understanding how available resources are adopted in a given political context. In this specific case, we selected two different indicators which deal with expenditure on education and army, respectively. While the former investment may be understood as a social benefit, the latter represents a concerning trend reflecting a world in which there is still place for war.

Looking at raw data (Figure 5), both indicators present a stable average value in the period with expenditure on education that nearly doubles military expenditure.
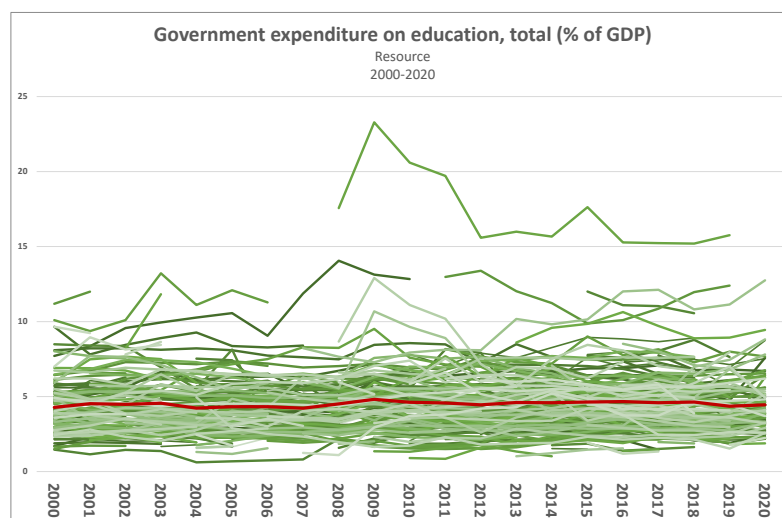
(a)

Figure 5. *Cont.*

(b)

Figure 5. Overview of the considered indicators in the category Resource. Green lines represent the values associated with single countries, while the red line shows the average value. (**a**) Expenditure on education [51]; (**b**) Military expenditure [50].

WTI for education (Figure 6) shows several fluctuations in the period but a very similar value at the two extremes (0.28 and 0.26). WTI for military expenditure (Figure 6) proposes a quite different pattern as maximum inequality is in 2000 with a clear reduction in 2020 (0.11).

The interpretation of WTI for this category is much less linear than for the previously proposed ones. Indeed, in an ideal case, we would like, first of all, to appreciate a clear decrease of military expenditure and a large increase in social investment. An alignment of purpose (decreasing WTI) would be an additional indicator of a growth in the right direction. Currently, the first condition is not clearly reflected in numbers, so the positive trend of WTI is probably less relevant than in other categories.
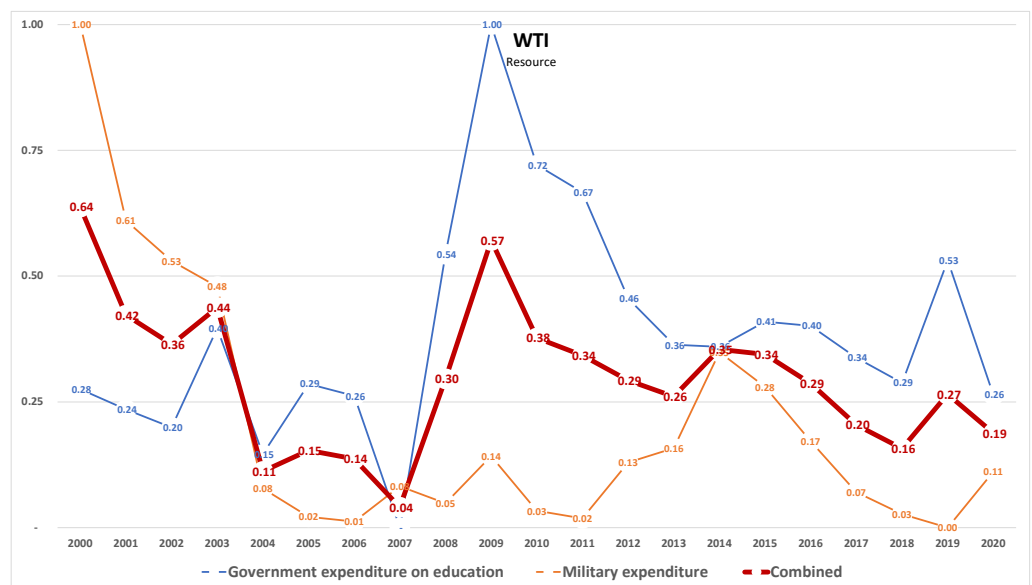

Figure 6. WTI—Resource. It results from computations on the raw data reported in Figure 5. The combined value is the average of the WTI for the different indicators.
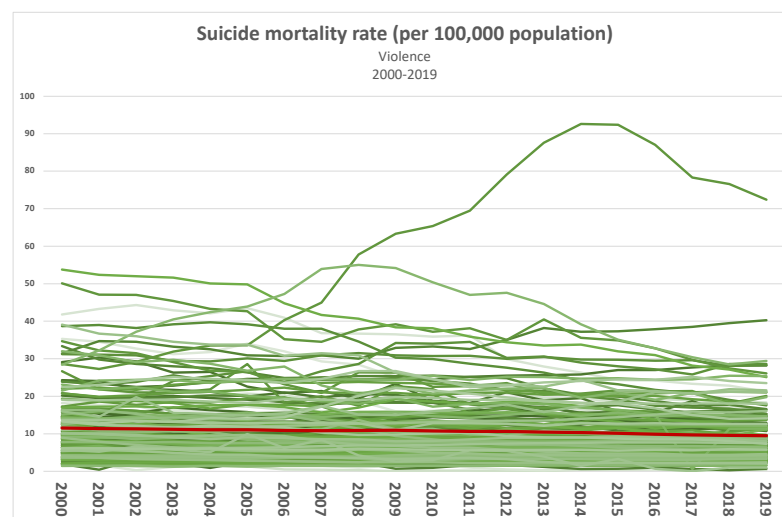
4.4. Violence

The category aims to capture a broad understanding of violence defined by WHO as "the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, which either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment, or deprivation" [58].

Due to the complexity of the concept and of its huge social impact, a large number of indicators should be considered. In order to keep the analysis as simple as possible, we selected two main statistics which aim to measure violence against others (*intentional homicides*) and self-harming (*suicide rate*).

The two selected indicators present a similar pattern with absolute trends averagely showing less violence (Figure 7a,b). This positive trend is clearly identifiable also at level of inequalities (Figure 8) that have been decreasing in the last few years.

(**a**)

(**b**)

Figure 7. Overview of the considered indicators in the category Violence. Green lines represent the values associated with single countries, while the red line shows the average value. (**a**) Intentional homicides [52]; (**b**) Suicide mortality rate [53].
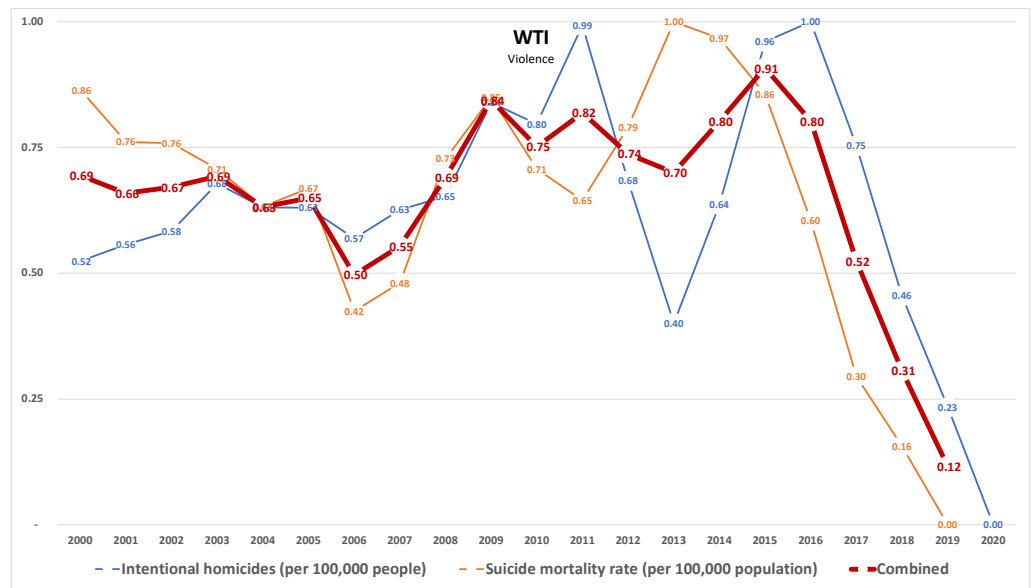
Figure 8. WTI—Violence. It results from computations on the raw data reported in Figure 7. The combined value is the average of the WTI for the different indicators.

5. Discussion and Recent Lessons

A summary of the computation results is proposed in Figure 9, which reports the average value of WTI for each considered category. As previously discussed, all categories present a relatively consolidated trend pointing to a fundamental reduction of inequality. This pattern is clearly visible looking at the average value among the different categories ("Overall" in the figure).
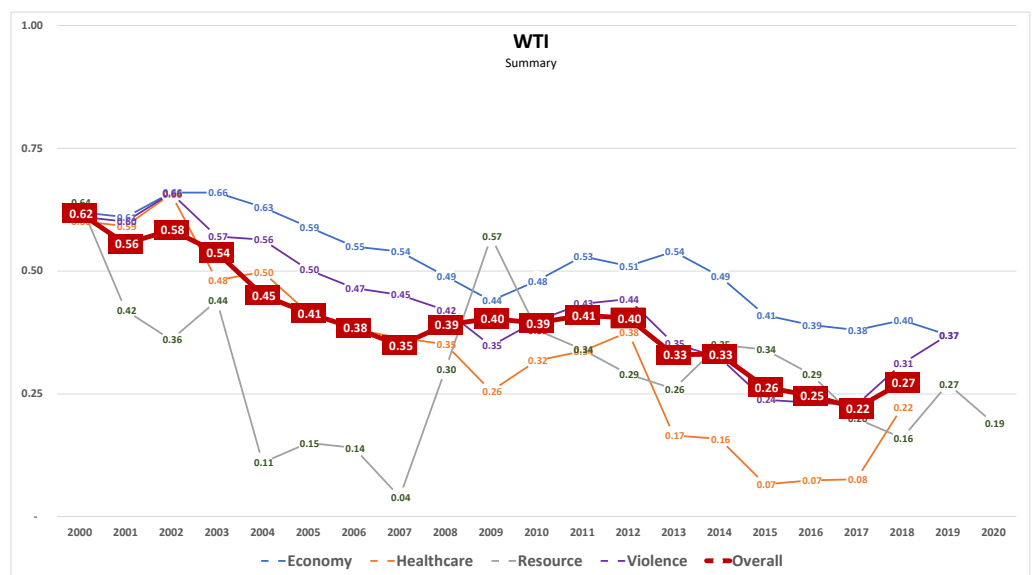

Figure 9. Result overview. The average value of WTI for each considered category is reported, as well as a combined indicator resulting from the different categories highlighted in red.

The conducted analysis presents a clear dependency on the selection of indicators and on data availability. Additionally, it relies exclusively on macro-indicators that are considered independently. Existing dependencies are not properly considered as their modelling and quantification could be extremely complex, if not impossible. Multiple different interpretations are possible, especially in a continuously evolving context; in the next sub-sections, we focus on two concrete reflections.

5.1. One Single Significant Anomaly

Despite the limitations addressed in the previous sections, the main trends seem to clearly indicate a scenario characterised by a fundamental reduction of inequalities in the different categories. Holistically, in the context of this work, that is equivalent to a world that is starting to "walk together" towards the direction of a socio-economic [59,60] and, eventually, also environmental justice [61–63].

However, also within the boundaries of this optimistic interpretation, it is impossible to not consider an evident anomaly related to the main economic indicator (GDP × capita) which shows an opposite trend.

The limitations of GDP are well known and have been extensively discussed in the literature (e.g., in [64,65]) and are an object of constant debate [66]. However, even in light of such considerations, it is conceptually complicated to think in a world that seems to walk together according to a number of parameters that largely depend on economy, while the economy itself goes in the opposite direction.

Contrasting trends while considering multiple indicators is fairly common (e.g., [67]). However, in this specific case, the important simplifications in the computational model in terms of dependencies and lack of weighting may have played a role to lead to such a contradiction. On the other hand, weighting the different indicators or categories [68] might introduce some bias, while, as previously mentioned in the paper, dependency implies much more complexity in the model.

5.2. Lessons from COVID-19

An additional concern, mostly in line with previous considerations, is related to the recent pandemic that has generated a global crisis [69]. Such an emergency can also be viewed as a kind of stress-test for our international community and society [70]. Along the different phases of the pandemic [71], huge differences among countries and regions emerged in the capability to respond to crisis [72] and recover [73].

The pandemic has also shown the fragility of the system. Indeed, although a global crisis—such as a pandemic—rarely affects all people in a uniform way [74], inequality could be considered as one of the major enablers [74]. In such a dramatic situation, the dangerous myth "COVID-19 does not discriminate" does not actually reflect a reality characterised by an increased vulnerability of those most socially and economically deprived [75].

The relationship between pandemic and inequality is an object of research interest. Indeed, unequal impact of COVID-19 on individuals, communities and nations is a fact often suppressed or invisible [76]. Recent studies address how the pandemic has revealed and worsened the social and economic inequalities that have emerged over the past several decades [77]. Additionally, COVID-19 revealed multiple inequalities [78]. An analysis at a country level presents several controversial issues, such as the trade-off between lives and income, as well as on the actual trend of international income inequality [79].

Specific mention is deserved by the access to vaccines which set up a challenge in global allocation [80]. While the most developed countries were dealing mostly with vaccine hesitancy [81] rather with the availability itself, less developed countries faced serious difficulties as most of the vaccines were reported to be reserved by wealthy nations [82]. This is a clear example of a world running at different speeds.

6. Conclusions and Future Work

Walking Together Indicator (WTI) is based on a simple model to foster transparency and broad communication. It relies on the statistical standard deviation to facilitate the measurement of inequality looking at single metrics (e.g., GDP), as well as at categories including multiple metrics (e.g., Economy).

Despite evident limitations (contextless comparison among countries), simplifications and approximations (significant lack of data), the study conducted on macro indicators presents a fundamental coherence in the result that shows a reducing inequality for all considered indicators with the exception of the main economic indicator. Therefore, the

mainstream trend, resulting from the analysis of single macro-indicators, presents an encouraging and optimistic outlook, but a deeper analysis points out possible different interpretations. Indeed, such a contrasting trend associated with the main economic indicator is partially explainable looking at the simplifications in the computational model, which neither considers dependencies among indicators nor assumes weighting. However, looking at the lessons learnt from the recent pandemic, which has shown a world running at different speeds, a more conservative interpretation of the indicator is probably the most advisable.

Future work will aim mostly to overcome current limitations, while keeping a simple and intuitive approach. MCDA techniques [68] could contribute to further enhance analysis capabilities, as well as modelling uncertainty and dependencies among indicators could foster a more contextual framework. Last but not least, a knowledge-based approach could increase dynamism via customisation, flexibility and re-use.

References

1. Mackenbach, J.P.; Kunst, A.E. Measuring the magnitude of socio-economic inequalities in health: An overview of available measures illustrated with two examples from Europe. *Soc. Sci. Med.* **1997**, *44*, 757–771. [CrossRef] [PubMed]
2. Barner, J.R.; Okech, D.; Camp, M.A. Socio-economic inequality, human trafficking, and the global slave trade. *Societies* **2014**, *4*, 148–160. [CrossRef]
3. Ghosh, S.; Doğan, B.; Can, M.; Shah, M.I.; Apergis, N. Does economic structure matter for ıncome ınequality? *Qual. Quant.* **2022**. [CrossRef]
4. Soubbotina, T.P.; Sheram, K. *Beyond Economic Growth: Meeting the Challenges of Global Development*; World Bank Publications: 2000.
5. Hopwood, B.; Mellor, M.; O'Brien, G. Sustainable development: Mapping different approaches. *Sustain. Dev.* **2005**, *13*, 38–52. [CrossRef]
6. Abashidze, A.K.; Inshakova, A.O.; Solntsev, A.M.; Gugunskiy, D.A. Socio-economic inequality as a barrier on the path of sustainable development: "institutional traps" and perspectives of overcoming them. *Int. J. Sociol. Soc. Policy* **2020**, *41*, 62–75. [CrossRef]
7. Bennis, W.G.; Nanus, B.; Bennis, S. *Leaders: Strategies for Taking Charge*; Harper & Row: New York, NY, USA, 1985; Volume 200.
8. Gidley, J.M. *The Future: A Very SHORT Introduction*; Oxford University Press: Oxford, UK, 2017.
9. Blackwood, D.; Lynch, R.G. The measurement of inequality and poverty: A policy maker's guide to the literature. *World Dev.* **1994**, *22*, 567–578. [CrossRef]
10. Farris, F.A. The Gini index and measures of inequality. *Am. Math. Mon.* **2010**, *117*, 851–864. [CrossRef]
11. Libório, M.P.; Martinuci, O.d.S.; Ekel, P.I.; Hadad, R.M.; Lyrio, R.d.M.; Bernardes, P. Measuring inequality through a non-compensatory approach. *GeoJournal* **2022**, *87*, 4689–4706. [CrossRef]
12. Van Phan, P.; O'Brien, M. Multidimensional wellbeing inequality in a developing country: A case study of Vietnam. *Soc. Indic. Res.* **2019**, *145*, 157–183. [CrossRef]
13. Thorbecke, E.; Charumilind, C. Economic inequality and its socioeconomic impact. *World Dev.* **2002**, *30*, 1477–1495. [CrossRef]
14. Mackenbach, J.P.; Stirbu, I.; Roskam, A.J.R.; Schaap, M.M.; Menvielle, G.; Leinsalu, M.; Kunst, A.E. Socioeconomic inequalities in health in 22 European countries. *N. Engl. J. Med.* **2008**, *358*, 2468–2481. [CrossRef]
15. Van de Poel, E.; Hosseinpoor, A.R.; Speybroeck, N.; Van Ourti, T.; Vega, J. Socioeconomic inequality in malnutrition in developing countries. *Bull. World Health Organ.* **2008**, *86*, 282–291. [CrossRef]
16. Huppert, F.A. The state of wellbeing science. *Concepts, Measures, Interventions, and Policies*; John Wiley & Sons: Hoboken, NJ, USA, 2014.
17. Schneider, S.M. Income inequality and subjective wellbeing: Trends, challenges, and research directions. *J. Happiness Stud.* **2016**, *17*, 1719–1739. [CrossRef]
18. Decancq, K.; Fleurbaey, M.; Schokkaert, E. Inequality, income, and well-being. In *Handbook of Income Distribution*; Elsevier: Amsterdam, The Netherlands, 2015; Volume 2, pp. 67–140.
19. Western, M.; Tomaszewski, W. Subjective wellbeing, objective wellbeing and inequality in Australia. *PloS ONE* **2016**, *11*, e0163345. [CrossRef]
20. Greve, B.; et al. What is welfare? *Cent. Eur. J. Public Policy* **2008**, *2*, 50–73.

21. Kakwani, N. Inequality, welfare and poverty: Three interrelated phenomena. In *Handbook of Income Inequality Measurement*; Springer: Berlin/Heidelberg, Germany, 1999; pp. 599–634.

22. Antràs, P.; De Gortari, A.; Itskhoki, O. Globalization, inequality and welfare. *J. Int. Econ.* **2017**, *108*, 387–412. [CrossRef]

23. Kakwani, N. Income inequality, welfare and poverty in a developing economy with applications to Sri Lanka. *Soc. Choice Welf.* **1988**, *5*, 199–222. [CrossRef]

24. Lewis, G.W.; Ulph, D.T. Poverty, inequality and welfare. *Econ. J.* **1988**, *98*, 117–131. [CrossRef]

25. Dutta, B. Inequality, poverty and welfare. *Handb. Soc. Choice Welf.* **2002**, *1*, 597–633.

26. Pyatt, G. Measuring welfare, poverty and inequality. *Econ. J.* **1987**, *97*, 459–467. [CrossRef]

27. Fritzell, J.; Lundberg, O. Health, inequalities, welfare and resources. In *Health Inequalities and Welfare Resources*; The Policy Press: Bristol, UK, 2006; pp. 1–18.

28. Bergqvist, K.; Yngwe, M.Å.; Lundberg, O. Understanding the role of welfare state characteristics for health and inequalities—An analytical review. *BMC Public Health* **2013**, *13*, 1234. [CrossRef] [PubMed]

29. Bambra, C. Health inequalities and welfare state regimes: Theoretical insights on a public health 'puzzle'. *J. Epidemiol. Community Health* **2011**, *65*, 740–745. [CrossRef] [PubMed]

30. Alkire, S. Dimensions of human development. *World Dev.* **2002**, *30*, 181–205. [CrossRef]

31. Birdsall, N. Rising inequality in the new global economy. *Int. J. Dev. Issues* **2006** .

32. Galbraith, J.K. Global inequality and global macroeconomics. *J. Policy Model.* **2007**, *29*, 587–607. [CrossRef]

33. Hughes, B.B.; Johnston, P.D. Sustainable futures: Policies for global development. *Futures* **2005**, *37*, 813–831. [CrossRef]

34. Forster, M.J. The world commission on environment and development. *Environ. Policy Law* **1985**, *14*, 22–35.

35. Freistein, K.; Mahlert, B. The potential for tackling inequality in the Sustainable Development Goals. *Third World Q.* **2016**, *37*, 2139–2155. [CrossRef]

36. Doyle, M.W.; Stiglitz, J.E. Eliminating extreme inequality: A sustainable development goal, 2015–2030. *Ethics Int. Aff.* **2014**, *28*, 5–13. [CrossRef]

37. Piketty, T. Income inequality in France, 1901–1998. *J. Political Econ.* **2003**, *111*, 1004–1042. [CrossRef]

38. Piketty, T.; Saez, E. Income inequality in the United States, 1913–1998. *Q. J. Econ.* **2003**, *118*, 1–41. [CrossRef]

39. Ravallion, M. Income inequality in the developing world. *Science* **2014**, *344*, 851–855. [CrossRef]

40. Wilkinson, R.G.; Pickett, K.E. Income inequality and social dysfunction. *Annu. Rev. Sociol.* **2009**, *35*, 493–511. [CrossRef]

41. Dabla-Norris, M.E.; Kochhar, M.K.; Suphaphiphat, M.N.; Ricka, M.F.; Tsounta, M.E. *Causes and Consequences of Income Inequality: A Global Perspective*; International Monetary Fund: Washington, DC, USA, 2015.

42. Solt, F. Standardizing the world income inequality database. *Soc. Sci. Q.* **2009**, *90*, 231–242. [CrossRef]

43. OECD. *Handbook on Constructing Composite Indicators: Methodology and User Guide*; OECD Publishing: Paris, France, 2008.

44. The World Bank—GDP Per Capita (Current US$). Available online: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD. (accessed on 9 May 2022).

45. The World Bank—Unemployment, Total (% of Total Labor Force). Available online: https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS (accessed on 10 May 2022).

46. Roser, M.; Ortiz-Ospina, E. Global Extreme Poverty. *Our World in Data*. Available online: https://ourworldindata.org/extreme-poverty (accessed on 10 May 2022).

47. The World Bank—Life Expectancy at Birth, Total (Years). Available online: https://data.worldbank.org/indicator/SP.DYN.LE00.IN (accessed on 10 May 2022).

48. The World Bank—Hospital Beds (per 1000 People). Available online: https://data.worldbank.org/indicator/SH.MED.BEDS.ZS (accessed on 10 May 2022).

49. The World Bank—Mortality Rate, under-5 (per 1000 Live Births). Available online: https://data.worldbank.org/indicator/SH.DYN.MORT (accessed on 10 May 2022).

50. The World Bank—Military Expenditure (% of GDP). Available online: https://data.worldbank.org/indicator/MS.MIL.XPND.GD.ZS (accessed on 10 May 2022).

51. The World Bank—Government Expenditure on Education, Total (% of GDP). Available online: https://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS (accessed on 10 May 2022).

52. The World Bank—Intentional Homicides (per 100,000 People). Available online: https://data.worldbank.org/indicator/VC.IHR.PSRC.P5 (accessed on 10 May 2022).

53. The World Bank—Suicide Mortality Rate (per 100,000 Population). Available online: https://data.worldbank.org/indicator/SH.STA.SUIC.P5 (accessed on 10 May 2022).

54. Libório, M.P.; Martinuci, O.d.S.; Laudares, S.; Lyrio, R.d.M.; Machado, A.M.C.; Bernardes, P.; Ekel, P. Measuring intra-urban inequality with structural equation modeling: A theory-grounded indicator. *Sustainability* **2020**, *12*, 8610. [CrossRef]

55. Mazziotta, M.; Pareto, A. Normalization methods for spatio-temporal analysis of environmental performance: Revisiting the Min–Max method. *Environmetrics* **2022**, *33*, e2730. [CrossRef]

56. Ruiz, F.; El Gibari, S.; Cabello, J.M.; Gómez, T. MRP-WSCI: Multiple reference point based weak and strong composite indicators. *Omega* **2020**, *95*, 102060. [CrossRef]

57. Pileggi, S.F. Holistic Resilience Index: Measuring the expected country resilience to pandemic. *Qual. Quant.* **2022**, *56*, 4107–4127. [CrossRef]

58. The VPA Approach—World Health Organization. Available online: https://www.who.int/groups/violence-prevention-alliance/approach (accessed on 10 May 2022).

59. Israel, E.; Frenkel, A. Social justice and spatial inequality: Toward a conceptual framework. *Prog. Hum. Geogr.* **2018**, *42*, 647–665. [CrossRef]

60. McAuliffe, G.; Danner, M.; Grothaus, T.; Doyle, L. Social inequality and social justice. *Cult. Alert Couns. Compr. Introd.* **2008**, 45–83.

61. Brulle, R.J.; Pellow, D.N. Environmental justice. *Annu. Rev. Public Health* **2006**, *27*, 103–124. [CrossRef] [PubMed]

62. Wenz, P. Environmental justice. In *Thinking About the Environment*; Routledge: Oxfordshire, UK, 2015; pp. 214–220.

63. Bowen, W. An analytical review of environmental justice research: What do we really know? *Environ. Manag.* **2002**, *29*, 3–15. [CrossRef]

64. Giannetti, B.F.; Agostinho, F.; Almeida, C.; Huisingh, D. A review of limitations of GDP and alternative indices to monitor human wellbeing and to manage eco-system functionality. *J. Clean. Prod.* **2015**, *87*, 11–25. [CrossRef]

65. England, R.W. Measurement of social well-being: Alternatives to gross domestic product. *Ecol. Econ.* **1998**, *25*, 89–103. [CrossRef]

66. Masood, E. Can An Economics Formula Save The Planet? *Nature* **2022**, *611* .

67. Dalstra, J.A.; Kunst, A.E.; Geurts, J.J.; Frenken, F.; Mackenbach, J.P. Trends in socioeconomic health inequalities in the Netherlands, 1981–1999. *J. Epidemiol. Community Health* **2002**, *56*, 927–934. [CrossRef]

68. Pileggi, S.F. Is the World Becoming a Better or a Worse Place? A Data-Driven Analysis. *Sustainability* **2020** , *12*, 88. [CrossRef]

69. Mishra, N.P.; Das, S.S.; Yadav, S.; Khan, W.; Afzal, M.; Alarifi, A.; Ansari, M.T.; Hasnain, M.S.; Nayak, A.K.; et al. Global impacts of pre-and post-COVID-19 pandemic: Focus on socio-economic consequences. *Sens. Int.* **2020**, *1*, 100042. [CrossRef]

70. Pileggi, S.F. Life before COVID-19: How was the World actually performing? *Qual. Quant.* **2021**, *55*, 1871–1888. [CrossRef]

71. Fakhruddin, B.S.; Blanchard, K.; Ragupathy, D. Are we there yet? The transition from response to recovery for the COVID-19 pandemic. *Prog. Disaster Sci.* **2020**, *7*, 100102. [CrossRef]

72. Janssen, M.; Van der Voort, H. Agile and adaptive governance in crisis response: Lessons from the COVID-19 pandemic. *Int. J. Inf. Manag.* **2020**, *55*, 102180. [CrossRef]

73. Delardas, O.; Kechagias, K.S.; Pontikos, P.N.; Giannos, P. Socio-Economic Impacts and Challenges of the Coronavirus Pandemic (COVID-19): An Updated Review. *Sustainability* **2022**, *14*, 9699. [CrossRef]

74. Ahmed, F.; Ahmed, N.; Pissarides, C.; Stiglitz, J. Why inequality could spread COVID-19. *Lancet Public Health* **2020**, *5*, e240. [CrossRef]

75. Patel, J.A.; Nielsen, F.; Badiani, A.A.; Assi, S.; Unadkat, V.; Patel, B.; Ravindrane, R.; Wardle, H. Poverty, inequality and COVID-19: The forgotten vulnerable. *Public Health* **2020**, *183*, 110. [CrossRef]

76. Nanda, S. Inequalities and COVID-19 1. In *COVID-19*; Routledge: Oxfordshire, UK, 2020; pp. 109–123.

77. Ashford, N.A.; Hall, R.P.; Arango-Quiroga, J.; Metaxas, K.A.; Showalter, A.L. Addressing inequality: The first step beyond COVID-19 and towards sustainability. *Sustainability* **2020**, *12*, 5404. [CrossRef]

78. Zheng, Y.; Walsham, G. Inequality of what? An intersectional approach to digital inequality under Covid-19. *Inf. Organ.* **2021**, *31*, 100341. [CrossRef]

79. Deaton, A. Covid-19 and global income inequality. Technical report, National Bureau of Economic Research. 2021. Available online: https://www.nber.org/system/files/working_papers/w28392/w28392.pdf (accessed on 10 May 2022).

80. Wouters, O.J.; Shadlen, K.C.; Salcher-Konrad, M.; Pollard, A.J.; Larson, H.J.; Teerawattananon, Y.; Jit, M. Challenges in ensuring global access to COVID-19 vaccines: production, affordability, allocation, and deployment. *Lancet* **2021**, *397*, 1023–1034. [CrossRef]

81. Sallam, M. COVID-19 vaccine hesitancy worldwide: A concise systematic review of vaccine acceptance rates. *Vaccines* **2021**, *9*, 160. [CrossRef]

82. Acharya, K.P.; Ghimire, T.R.; Subramanya, S.H. Access to and equitable distribution of COVID-19 vaccine in low-income countries. *NPJ Vaccines* **2021**, *6*, 54. [CrossRef]