



Tulane Economics Working Paper Series

Beyond GDP: Simple Preference-Based Wellbeing Indicators

Benoit Decerf
University of Namur
DEFIPP
benoit.decerf@unamur.be

Marc Fleurbaey
Paris School of Economics

Carol Graham
Brookings
Institution/University of
Maryland

Nora Lustig
Tulane University

Working Paper 2610
October 2026

Abstract

We develop a unified and operational preference-based framework for constructing simple headline indicators of current wellbeing. High-profile Beyond GDP indicators lack solid conceptual foundations and are therefore based on ad-hoc choices. As a result, they risk making comparisons that people would find implausible. Beyond GDP indicators grounded in preference-based social welfare functions (SWF) offer a solution to this issue, but current proposals are hard to communicate and pay insufficient attention to data constraints, so they remain largely confined to academic circles. Our framework builds up a headline indicator through a sequence of preference-based adjustments to GDP per capita: first for average non-monetary achievements, then for inequality in the distribution of wellbeing, and finally for monetary poverty and non-monetary deprivations. This last adjustment is a central contribution of the paper: existing Beyond GDP indicators typically adjust for average achievements and, in some cases, for inequality, but they generally leave out income poverty and non-monetary deprivation, even though these are dimensions that policymakers care about deeply and that are central to how societies experience wellbeing. The framework is modular and agnostic about which wellbeing aspects to integrate, and it gives its preference parameters a clear, elicitable interpretation. An empirical illustration for a large set of countries shows how the framework can be applied, and how much rankings and trends change once achievements in nonmonetary dimensions such as life expectancy, inequality, and then poverty and deprivation, are taken into account.

Keywords: Beyond GDP, well-being indicator, HDI, Composite indicator, Weight
JEL codes: D63, D71, O57, P17

Beyond GDP: Simple Preference-Based Wellbeing Indicators*

Benoit Decerf,[†]Marc Fleurbaey,[‡]Carol Graham,[§]Nora Lustig[¶]

October 2026

Abstract

We develop a unified and operational preference-based framework for constructing simple headline indicators of current wellbeing. High-profile Beyond GDP indicators lack solid conceptual foundations and are therefore based on ad-hoc choices. As a result, they risk making comparisons that people would find implausible. Beyond GDP indicators grounded in preference-based social welfare functions (SWF) offer a solution to this issue, but current proposals are hard to communicate and pay insufficient attention to data constraints, so they remain largely confined to academic circles. Our framework builds up a headline indicator through a sequence of preference-based adjustments to GDP per capita: first for average non-monetary achievements, then for inequality in the distribution of wellbeing, and finally for monetary poverty and non-monetary deprivations. This last adjustment is a central contribution of the paper: existing Beyond GDP indicators typically adjust for average achievements and, in some cases, for inequality, but they generally leave out income poverty and non-monetary deprivation, even though these are dimensions that policymakers care about deeply and that are central to how societies experience wellbeing. The framework is modular and agnostic about which wellbeing aspects to integrate, and it gives its preference parameters a clear, elicitable interpretation. An empirical illustration for a large set of countries shows how the framework can be applied, and how much rankings and trends change once achievements in nonmonetary dimensions such as life expectancy, inequality, and then poverty and deprivation, are taken into account.

JEL: D63, D71, O57, P17.

Keywords: Beyond GDP, well-being indicator, HDI, Composite indicator, Weight.

*Acknowledgments: We are grateful to Felix Dopchie for outstanding research assistance with the empirical section and from Daniel Hopp for the preparation of the data. This project benefited from insights and comments provided by the UN's high-level working group on "Beyond GDP" (including Kaushik Basu, Naila Kabeer), as well as experts from the World Bank (including Christoph Lakner, Dean Jolliffe, Daniel Mahler, Aart Kraay, Jed Friedman, Nishant Yonzan), and a large set of scholars, including Sabina Alkire, Francois Bourguignon, Koen Decancq, James Foster, Erik Schokkaert, Suman Seth. We thank seminar audiences at Namur University and the participants in the "Beyond GDP" International Research & Policy Workshop at LSE. This project benefited from a grant. All errors remain ours.

[†]University of Namur, DEFIPP. Email: benoit.decerf@unamur.be.

[‡]Paris School of Economics

[§]Brookings Institution/University of Maryland

[¶]Tulane University

1 Motivation

GDP overlooks important non-monetary dimensions of wellbeing and pays little attention to equity. Comparisons based solely on GDP are too disconnected from how people perceive their own wellbeing. This observation inspired a series of Beyond GDP initiatives, notably Brundtland (1987), Stiglitz et al. (2009b), the OECD Better Life Index, and, most recently, the United Nations Secretary-General’s independent High-Level Expert Group on Beyond GDP, whose report, *Counting What Counts: A Compass of Progress for People and Planet*, was published in May 2026. Collectively, these initiatives have greatly advanced the measurement of wellbeing by developing multidimensional frameworks and, in many cases, dashboards of indicators to monitor multiple aspects of social progress.

Valuable as these dashboards are, they are not sufficient. They do not provide clear answers to fundamental questions such as: Is wellbeing improving? How rapidly is progress occurring? How far behind are the lagging countries? Are disparities narrowing over time? Because dashboards present multiple indicators without summarizing overall performance, they are difficult to operationalize, provide no single high-level picture of societal progress, and are challenging to communicate effectively to policymakers and the public. For these reasons, dashboards should be complemented by one or more headline indicators of current wellbeing.

There is a large literature on headline indicators of current wellbeing. This literature has not achieved a consensus, and this is not surprising since multiple conceptions of a good society and multiple theories of social justice compete in the academic literature and in public debates. We take the view that the main schools of thought, whether they consider subjective wellbeing, capabilities, resources or preference-based measures of wellbeing, deserve statistics that reflect their concerns and their social principles.¹ In this paper, we develop a set of indicators that belong to the class of money-metric (also called equivalent income) indexes, which have the distinct feature of being expressed in the familiar metric of money but incorporate non-monetary aspects of quality of life taking account of the preferences of the population. They therefore belong to the larger family of “preference-based” indicators. The indicators we develop resonate with conceptions of the good society that focus on living conditions (income, consumption, quality of life) but respect the population’s values as far as trade-offs between dimensions of life are concerned.² A more detailed review of the various schools of thought is provided in Section 7 to help readers locate our approach in the broader conceptual landscape.

Putting the philosophical foundation aside, in empirical economic and statistical applications, one can distinguish two main sets of approaches to the construction of headline indicators.

First are the “practice-driven” approaches. These approaches first select several aspect-specific indicators, then normalize each of them and finally aggregate the normalized indi-

¹There is also the issue of whether sustainability should be added to the main headline indicators or should be treated as a separate question from the measurement of current wellbeing. Both Stiglitz et al. (2009a) and the recent UN HLEG Report recommend separating the two questions. We follow this approach here and focus on the measurement of current wellbeing.

²Like Fleurbaey (2009) and Fleurbaey and Blanchet (2013), we therefore believe that such indicators are closer to the broad class of theories of justice initiated by John Rawls, Ronald Dworkin, Amartya Sen or Martha Nussbaum than to other schools of thought. According to the theories in this broad “Rawlsian” class, people’s values matter and must be respected, but inequalities should be assessed in terms of life resources, opportunities and achievements rather than in terms of subjective satisfaction.

cators into composite indicators using weights. These approaches dominate the landscape of applied indicators, notably because they meet the communication needs and data constraints faced by practitioners. Examples include the Human Development Index (HDI), the Better Life Index or the Social Progress Index. However, “practice-driven” indicators do not rely on clear conceptual foundations. As a result, their mathematical formula is ad-hoc and their weights have no straightforward relationships with the trade-offs that the headline indicator makes across the relevant aspects (Decancq and Lugo, 2013).³ This leads to their main limitation. Practice-driven indicators are at risk of making wellbeing comparisons that people would deem implausible.

This limitation has been crudely exposed by Ravallion (2012) in the case of the 2010 definition of the HDI Klugman et al. (2011). Ravallion observed that the HDI implicitly considered it an improvement that life expectancy in Zimbabwe be reduced by one year provided yearly GDP per capita in this country increased by a mere 0.51 dollars. He disparagingly called “mash-up” the composite indicators developed following the practice-driven approach. He argued there is no added value for composite indicators whose wellbeing comparisons can be utterly implausible. This important limitation is the result of a “mirage of simplicity”. It is typically simple to communicate a composite indicator’s mathematical formula and the value selected for its weights. However, this information does not directly reveal the crucial piece of information to assess their validity, namely the trade-offs they implicitly make across different aspects of wellbeing. In that sense, these indicators effectively work as black boxes.

Due to these issues, we argue that it is preferable to pursue one of the possible “conceptually-founded” approaches, and this paper develops one particular line, following in the footsteps of Fleurbaey and Gaulier (2009), Jones and Klenow (2016) or Boarini et al. (2022). Our key motivation is that conceptually-founded indicators have been largely confined to academic circles. We argue this state of affairs prevails because they often involve complex formulae and do not sufficiently cater to the communication needs and data constraints faced by practitioners. This paper therefore proposes a new framework for the construction of headline indicators of current wellbeing, which we call BGD_P indicators. BGD_P indicators are simplified versions of preference-based social welfare functions. Their construction aims at meeting the needs of practitioners for transparency and simplicity. Yet, their conceptual foundation guards them against the risk of making comparisons that people would deem implausible. Importantly, the proposed framework is modular: the set of wellbeing aspects incorporated can vary. This is desirable because views differ on which aspects to include, and it is also convenient under data constraints. Moreover, the paper shows that BGD_P indicators can combine poverty-related adjustments together with inequality-related adjustments without double-counting. An empirical illustration shows how the framework can be applied and how easy it can be to analyze and communicate results.

The paper establishes a list of assumptions that allow moving from a preference-based social welfare function (SWF) to a simplified BGD_P indicator. Establishing this link first ensures that the mathematical expression of a BGD_P indicator is not ad-hoc but conceptually-grounded. Second, BGD_P indicators start from GDP and then multiply it by a series of adjustment factors, one for each aspect deemed relevant. This multiplicative structure as well as the mathematical expression for the adjustment factors is related

³Truly enough, the HDI literature usually proclaims close proximity with A. Sen’s capability approach. However, the connection is quite loose, since the weights in the HDI ignore Sen’s arguments for adopting reasoned aggregation weights that reflect the values of the populations.

to the SWF and it makes it possible to decompose BGDG variations into the relevant wellbeing aspects, a feature that greatly simplifies the analysis by revealing which aspects drive the change. Third, the weights inherit a well-defined meaning, understandable units, and their values can be selected by eliciting preferences. This aspect helps guarding BGDG indicators against the risk of making implausible comparisons.

BGDG indicators aim at striking a good balance between conceptual validity and “practicability”, which refers to the communication and data constraints faced by practitioners. Compromise is necessary as there may exist trade-offs between these two objectives. In particular, [Kraay et al. \(2023\)](#) show that there exists no social welfare indicator that is simultaneously distribution-sensitive, decomposable in subgroups and is expressed in income units. Our class of BGDG indicators indeed lacks subgroup separability, but this issue is further discussed in the paper.

We make one original conceptual contribution: we show that a single summary indicator can meaningfully integrate inequality and poverty adjustments together, without double-counting, within one unified framework. This matters because existing Beyond GDP indicators typically adjust for average achievements and, in some cases, for inequality, but generally do not account for income poverty or non-monetary deprivations, even though these are two dimensions that policymakers care deeply about and that are central to assessing the extent of wellbeing enjoyed by a society. Fundamentally, poverty must be treated separately from inequality because mainstream inequality indices do not capture all distributional aspects that matter to social wellbeing, in particular when society places a particular emphasis on people falling below some poverty or deprivation standard. Integrating poverty measures into summary indicators increases their policy relevance given their visibility in the media and the emphasis that policymakers place on them. Also, integrating poverty allows attributing a particular priority to the poor and it further emphasizes the poverty reduction achieved by developing countries.

The remainder is organized as follows. Section 2 presents the BGDG framework. Section 3 derives a first BGDG indicator that adjusts GDP for average outcomes only, through a pass-through to the relevant notion of income and an adjustment for average non-monetary outcomes. Section 4 adds an adjustment for inequality in equivalent incomes. Step-by-step empirical illustrations of the intermediate indicators derived in Sections 3 and 4 are presented in [Appendix 9.2](#) and [Appendix 9.3](#), respectively. Section 5 adds two further adjustment factors, for monetary poverty and for non-monetary deprivations. Each of these three sections (3, 4 and 5) introduces the simplifying assumptions it requires, derives the corresponding adjustment factors and then applies them, so that the indicator is built up one component at a time. Section 6 presents an empirical illustration of the resulting BGDG indicator, which combines four adjustment factors. The relationships between our BGDG indicators and the broad set of beyond GDP headline indicators are discussed in Section 7. Section 8 concludes and discusses a few open questions left to future research.

2 The BGDG framework

We use the term BGDG to refer to a headline indicator of current wellbeing. Our central contribution is not any single BGDG indicator but a unified preference-based framework within which successive BGDG indicators are constructed, each adding one further preference-based adjustment to GDP per capita: first for average non-monetary achieve-

ments, then for inequality, and finally for monetary poverty and non-monetary deprivation. In this section, we present the main features of the framework, discuss its key advantages, and explain how its preference parameters can be interpreted and, in principle, elicited.⁴ Sections 3 to 6 provide more concrete definitions for each adjustment and illustrate empirically how the framework can be implemented.

At its core, a BGDP indicator is obtained by multiplying GDP per capita by a series of adjustment factors, i.e., where GDP denotes GDP per capita, adjustment factor A_ℓ adjusts GDP for a particular aspect of current wellbeing and the denominator A_ℓ^* is a constant equal to a reference value for adjustment factor A_ℓ .

$$BGDP = GDP \times \prod_{\ell=1}^L \frac{A_\ell}{A_\ell^*}. \quad (1)$$

The normalization by A_ℓ^* serves communication purposes. A normalized adjustment factor greater than 1 indicates that performance in aspect ℓ exceeds the reference value, whereas a value below 1 indicates that it falls short of the reference. Importantly, this normalization does *not* affect BGDP comparisons.⁵ This is unlike the normalizations used in the construction of composite indicators like the HDI, which have non-trivial implications for their comparisons (Decancq and Lugo, 2013).

A distinguishing feature of the BGDP framework is that it is conceptually grounded in a preference-based social welfare function (SWF). This grounding provides a clear normative interpretation of the indicator: under a well-defined set of simplifying assumptions, BGDP generates the same welfare comparisons as the underlying SWF. The canonical formula for the SWF is introduced below

$$SWF = \frac{1}{N} \sum_{i=1}^N u_i(y_i, x_i), \quad (2)$$

with y_i denoting the monetary outcome of individual i (e.g., income or consumption), $x_i = (x_{i1}, \dots, x_{iJ})$ denoting her outcomes in the relevant non-monetary dimensions, and $u_i(y_i, x_i)$ denoting her preference-based individual wellbeing index.⁶

Importantly, grounding BGDP in a SWF ensures that the trade-offs embodied in the indicator have a coherent normative interpretation. The associated weights are linked to the marginal rates of substitution implied by the underlying preferences, and their values can be calibrated or elicited to reflect individual or social preferences over the different aspects of wellbeing. In contrast, when the aggregation formula is chosen independently of an underlying SWF, there is no reason to expect that the implied trade-offs coincide with those that individuals or society would consider desirable.⁷

We make five additional remarks on Eq. (1).

First, BGDP is a modular indicator. Practitioners can select the adjustment factors that best fit their purposes and simply omit the others. The result is a tailored BGDP indicator, with no further modifications required. This modularity offers another important

⁴Section 9.1 presents one method to select values for these preference parameters.

⁵Unlike composite indicators, BGDP can straightforwardly accommodate both bounded and unbounded aspect-specific indicators.

⁶That is, the utility function u_i represents the preference of individual i over pairs (y_i, x_i) of monetary and non-monetary outcomes.

⁷The value for the weight depends on the aspect-specific indicator considered.

advantage: the framework is agnostic about which aspects should be included in current wellbeing, an issue on which broad consensus is unlikely. For example, BGDP is agnostic about the monetary outcome used to capture material wellbeing (e.g., household disposable income, consumption, or another measure), the non-monetary dimensions included (e.g., health, education, both, or neither), and whether the relevant notion of inequality is inequality of outcomes or inequality of opportunity.

Second, and relatedly, the BGDP framework offers different solutions against data constraints. Its modularity allows adding or dropping adjustment factors as a function of data availability. Also, BGDP can be constructed even when the joint distribution of outcomes is not fully observed. In particular, BGDP can combine achievements collected through separate surveys.

Third, BGDP is expressed in income units. These units have a cardinal interpretation, making it possible to answer the very questions for which a headline indicator is needed (see Introduction). At the same time, expressing BGDP in income units does not, in itself, assign any special importance to monetary outcomes in wellbeing comparisons. Indeed, BGDP could be transformed into an equivalent indicator expressed in other units – for example, years of life – without changing the comparisons it generates. What determines those comparisons is not the choice of units but the values assigned to the weights.

Fourth, BGDP’s multiplicative structure implies that changes in BGDP are additively separable. This property facilitates the analysis of trends over time and cross-country comparisons. For example, the change in BGDP from period t to t' can be decomposed as follows:

$$BGDP \text{ growth} \approx \ln \left(\frac{BGDP'}{BGDP} \right) = \underbrace{\ln \left(\frac{GDP'}{GDP} \right)}_{\approx GDP \text{ growth}} + \sum_{\ell=1}^L \ln \left(\frac{A'_\ell}{A_\ell} \right) \quad (3)$$

This decomposition straightforwardly identifies the main sources of progress or decline. Eq. (3) is expressed in log income units, which allows for a particularly simple interpretation when changes are small. Specifically, the change in BGDP is approximately equal to the counterfactual GDP growth that would have produced the same improvement in BGDP had all other aspects of wellbeing remained unchanged. In this sense, the change in BGDP can be interpreted as the equivalent GDP growth between t and t' . This interpretation follows from the approximation $\ln(1+x) \approx x$ for $x \in [-0.2, 0.2]$.⁸ In practice, this approximation is highly accurate in many relevant applications, such as evaluating a country’s progress over a period of a few years or comparing countries at similar levels of development.

Fifth, BGDP is not subgroup decomposable with population weights, unlike the underlying SWF defined in Eq. (2). This property is lost through the EDE transformation used to simplify the interpretation of BGDP. The lack of subgroup decomposability has important implications for how BGDP should – and should not – be used. In particular, global wellbeing should be pursued by maximizing global BGDP directly, not by maximizing a population-weighted sum of country-level BGDPs. Likewise, an international development agency should not allocate resources by comparing their marginal effects on country-level BGDPs. An additional unit of BGDP (measured in currency units) in one country is not comparable to an additional unit of BGDP in another country. Allocating resources on the basis of such comparisons would be regressive because it would systematically favor countries with higher initial levels of wellbeing. Note, however, that the

⁸For $\ln(1+y) = x \notin [-0.2, 0.2]$, we have $y \not\approx x$, which forces using the exact formula $1+y = e^x$.

indicators underlying particular adjustment factors may themselves be subgroup decomposable. This property may, for example, facilitate analyses by gender or other population groups and may also simplify the computation of global BGD⁹.

Readers uninterested in the conceptual foundations for the various adjustment factors can skip sections 3, 4 and 5 and directly go to the empirical illustration proposed in Section 6.

3 Average equivalent income

In this section we derive two types of adjustment factors: a pass-through that defines the relevant monetary outcome, and adjustments for average non-monetary outcomes. The simplifying assumptions required for the derivations are introduced as they arise rather than gathered in a separate subsection. We then derive each type of adjustment factor in turn.

There are N individuals indexed by i , and J non-monetary outcomes indexed by j . Consider a distribution of monetary outcomes $(y_1, \dots, y_N) \in \mathbb{R}_+^N$, which we henceforth call “incomes” for simplicity, and a distribution of non-monetary outcomes $(x_1, \dots, x_N)$ where $x_i = (x_{i1}, \dots, x_{iJ}) \in \mathbb{R}^J$. Individual i has well-behaved preferences over bundles (y_i, x_i) , which are represented by the utility function $u_i : \mathbb{R}_+ \times \mathbb{R}^J \rightarrow \mathbb{R}$.

We assume throughout that preferences are homogeneous, i.e., $u_i = u_{i'} = u$ for all $i, i' \in \{1, \dots, N\}$ (**assumption 1**). We leave to future research the development of BGD⁹ indicators based on heterogeneous preferences.

We consider a particular representation of the common preference u , inspired from [Fleurbaey and Gaulier \(2009\)](#). This representation is known as “equivalent income” ([Samuelson and Swamy, 1974](#)). It is based on a (fixed) reference value for non-monetary outcomes, denoted $x^* = (x_1^*, \dots, x_J^*)$. The equivalent income w_i of individual i when consuming bundle (y_i, x_i) is the income level that she would consider equally good if her non-monetary outcomes were x^* instead of x_i . The equivalent income is implicitly defined by

$$u(y_i, x_i) = u(\underbrace{y_i - WTP(y_i, x_i, x^*)}_{:=w_i}, x^*) \quad (4)$$

where $WTP(y_i, x_i, x^*)$ denotes i ’s willingness-to-pay to enjoy the reference vector x^* instead of x_i . Observe we find convenient that our notation w_i omits its dependence on (y_i, x_i, x^*) .

We make an important remark. Even though BGD⁹ indicators are grounded in the notion of willingness-to-pay, they will not necessarily prioritize individuals with higher willingness-to-pay. The reason is that the SWF in Eq. (2) weighs less a dollar given to a well-off individual than a dollar given to a less well-off individual. Indeed, the SWF sums individual wellbeing indices (constructed from function u) rather than equivalent incomes w_i . The larger social weight attributed to a dollar going to a less well-off individual derives from the concavity of function u .

⁹If each of BGD⁹’s aspect-related indicators are subgroup decomposable, then global BGD⁹ is constructed from the population-weighted country-level aspect-related indicators, which provide their global value.

A multiplicative expression

Let $\bar{y}$ and $\bar{w}$ respectively denote average income and average equivalent income. We next present a series of simplifying assumptions that allow deriving a multiplicative expression for $\bar{w}$.

First, we assume that willingness-to-pay is additively separable across dimensions, i.e.,

$$WTP(y_i, x_i, x^*) = \sum_{j=1}^J WTP(y_i, x_{ij}, x_j^*) \quad (5)$$

where $WTP(y_i, x_{ij}, x_j^*)$ denotes the willingness-to-pay to reach the reference achievement in dimension j , denoted by x_j^* (**assumption 2**).

Second, we assume that marginal willingness-to-pay is proportional to income, based on a fixed proportion (**assumption 3**), i.e., for all j we have

$$WTP(y_i, x_{ij}, x_j^*) = \gamma_j \times y_i \times (x_j^* - x_{ij}). \quad (6)$$

This calls for a few remarks.

First, the preference parameter γ_j , which governs the exchange rate between income and achievement in dimension j , has a straightforward interpretation. Indeed, γ_j captures the fraction of her income a person is willing to give up to increase her achievement in dimension j by one unit. This parameter thus has intuitive units. For instance, if the health dimension is captured through life expectancy, then γ_j is the fraction of her income a person is willing to pay to gain one year of life expectancy.

Second, these simplifying assumptions on WTP imply that the marginal rate of substitution between any two non-monetary dimensions j and j' is fixed and equal to $\gamma_j/\gamma_{j'}$. This is unrealistic and is thus a limitation of this approach, but it brings considerable simplicity. The poverty and deprivation adjustments, presented in section 5, help improve on this limitation.

From these two assumptions, we get

$$\bar{w} = \bar{y} - \frac{1}{N} \sum_{i=1}^N \sum_{j=1}^J (\gamma_j \times y_i \times (x_j^* - x_{ij})). \quad (7)$$

We next assume for all dimensions j that the covariance between y_i and x_{ij} is zero (**assumption 4**). Letting $\bar{x}_j$ denote the average achievement in dimension j , this assumption is that $\frac{1}{N} \sum_{i=1}^N (y_i \times x_{ij}) = \bar{y} \times \bar{x}_j$.¹⁰ This assumption is unlikely to hold in practice, but it yields the following simplification:

$$\bar{w} = \bar{y} \times \left(1 - \sum_{j=1}^J (\gamma_j \times (x_j^* - \bar{x}_j)) \right) \quad (8)$$

¹⁰The full formula with the covariance is

$$\bar{w} = \bar{y} \times \left(1 - \sum_{j=1}^J \gamma_j \times (x_j^* - \bar{x}_j) \times (1 + NCov(y, x_j^* - x_j)) \right)$$

where the normalized covariance is

$$NCov(y, x_j^* - x_j) = \frac{Cov(y, x_j^* - x_j)}{\bar{y} \times (x_j^* - \bar{x}_j)}.$$

When the average achievements are not too far from the reference achievements, implying that average WTP to get to the reference achievements is not too large compared to average income, we can use the approximation¹¹

$$\begin{aligned}\bar{w} &\approx \bar{y} \times e^{\sum_{j=1}^J (\gamma_j \times (\bar{x}_j - x_j^*))} \\ &= \bar{y} \times \prod_{j=1}^J e^{\gamma_j \times (\bar{x}_j - x_j^*)}\end{aligned}\tag{9}$$

which provides a multiplicative expression for (an approximation of) the average equivalent income.

We make two remarks on Eq. (9).

First, Eq. (9) implies that the common individual preferences can be represented by the function

$$\ln(y_i) + \sum_{j=1}^J \gamma_j x_{ij}\tag{10}$$

This function is the classical function used in SWB regressions (see Appendix 9.1). This function has two convenient features. The impact of a change in the x variables is additively separable. Also, the willingness-to-pay for a change in the x variables is proportional to income, which is realistic (assumption 3).

Second, the reference non-monetary bundle x^* simply rescales the value of $\bar{w}$ by a constant factor. As a result, the choice of x^* does not affect the comparison of societies in terms of their average equivalent incomes. In other words, the selection of the reference non-monetary bundle becomes irrelevant. Practitioners may find this irrelevance attractive as it reduces the number of parameters to be debated.

Pass-through to the relevant notion of income

GDP per capita need not be the relevant indicator for average monetary outcome $\bar{y}$. Indeed, GDP captures expenses unrelated to current wellbeing, like investments in capital that will only improve future wellbeing. Also, some expenses captured by GDP may already be captured by non-monetary outcomes. For instance, health expenditures improve health outcomes (x_{health}). Such expenses should be removed to avoid double counting.

When $\bar{y} \neq GDP$, the obvious solution is for one adjustment factor to be defined as a “pass-through” so that

$$A_{PT} = \frac{\bar{y}}{GDP}\tag{11}$$

Clearly, multiplying GDP by this pass-through renders GDP irrelevant for BGDG comparisons. This adjustment factor may still convey interesting information on the fraction of GDP that translates into monetary wellbeing.

Such pass-through allows the BGDG framework to remain agnostic on the relevant notion of income.

¹¹Again, the approximation taken is that $1 + a \approx e^a$, which holds approximately when $a \approx 0$.

Adjusting for average non-monetary outcome

Eq. (9) provides the foundation for an adjustment factor that corrects for average non-monetary outcomes.

Formally, we have

$$A_{av.j} = e^{\gamma_j \times \bar{x}_j} \quad (12)$$

where $\bar{x}_j$ denotes the average achievement in non-monetary outcome j and γ_j is the weight given to an additional unit of $\bar{x}_j$.

We make three remarks on the weight γ_j .

First, weight γ_j inherits a clear interpretation from Eq. (6). γ_j is the fraction of their income that people would be willing to give up to live in a society that secures an additional unit of non-monetary outcome j . This weight directly captures the trade-off between one unit of dimension j and income. This provides a great advantage. Indeed, people can directly appraise whether they find that the value selected for γ_j is plausible or completely off. This is unlike the weights entering composite headline indicators like the HDI. These composite indicators hide the true trade-off they make across dimensions. Indeed, for these indicators, the relevant trade-off depends in complex ways on the value selected for the weight and on the normalization used (Decancq and Lugo, 2013).¹² As a result, people have typically no clue about the implied trade-off. Under these conditions, it is doubtful that the practice of asking people to select values for composite weights yield meaningful results. To some extent, the same can hold for practitioners. This can lead to implausible trade-offs, as shown by Ravallion (2012). The apparent simplicity offered by composite indices is not only illusory, it can also be harmful.

Second, the value for weight γ_j can be selected by eliciting preferences over this non-monetary outcome. There is a large literature developing various preference elicitation methods, each coming with advantages and shortcomings.¹³ One direct solution is to measure the willingness-to-pay for an additional unit of j . As discussed in section 9.1, the mathematical expression for BGDP and the weight for non-monetary outcome imply that weight γ_j can be elicited from standard subjective wellbeing regressions.

Third, the value for weight γ_j depends on the units in which $\bar{x}_j$ is measured. For instance, if life expectancy is expressed in months rather than in years, then its weight should be divided by twelve.

A step-by-step empirical illustration of adjustment $A_{av.j}$ is presented in Appendix 9.2.

4 Inequality

In this section we derive the adjustment factor that corrects for inequality in equivalent incomes.

Inequality in equivalent incomes

Atkinson (1970) lays out the foundation for an inequality adjustment. Let $w = (w_1, \dots, w_N)$ denote the distribution of equivalent incomes.

¹²In contrast, the normalization used by BGDP does not affect the trade-offs made across dimensions.

¹³See Da Costa et al. (2026) for a review of preference elicitation techniques for the purpose of computing equivalent income.

The homogeneous preference assumption together with the notion of equivalent income allows rewriting the SWF defined in Eq. (2) as

$$SWF(w) = \frac{1}{N} \sum_{i=1}^N v(w_i) \quad (13)$$

where $v(w_i) = u(y_i, x_i)$ for all bundles (y_i, x_i) .

Atkinson observes that the concavity of function v captures the social welfare losses associated to the unequal distribution of (equivalent) incomes. Atkinson (1970) proposes that this SWF be represented by its equally-distributed equivalent income (EDE), denoted by $\tilde{w}$ (where $\tilde{w} \in \mathbb{R}_+$), which is implicitly defined by $v(\tilde{w}) = SWF(w)$. The EDE is the level of (equivalent) income that yields the same level of social welfare if all enjoy this common (equivalent) income. Atkinson defines the relevant inequality index to be

$$I(w) = 1 - \frac{\tilde{w}}{\bar{w}} \quad (14)$$

so that the EDE, which represents the SWF, can be expressed as

$$\tilde{w} = v^{-1}(SWF(w)) = \bar{w} \times (1 - I(w)) \quad (15)$$

which provides a multiplicative expression for an indicator that represents the SWF.

Data constraint: joint distribution only partially observed

Eq. (15) is based on an index of inequality in equivalent incomes ($I(w)$). This index can only be computed if we observe individual bundles (y_i, x_i) . However, the joint distribution over achievements in different dimensions is typically not fully observed because achievements in different dimensions are sometimes collected through separate surveys.

Given this data constraint, the solution we adopt in our empirical illustration is to assume that the inequality in equivalent incomes is equal to the inequality in incomes (**assumption 5**), i.e.,

$$I(w) \approx I(y) \quad (16)$$

Assumption 5 implies an important limitation. The cumulation of low achievements in several dimensions is not accounted for.

As a result, this solution likely underestimates $I(w)$, at least it would be the case if non-monetary achievements are not negatively correlated to income. In that case, if individual i has a low income y_i , then she also has low non-monetary achievement x_{ij} , which implies a proportionally larger willingness-to-pay for the reference achievement x_j^* .

Another solution, if data is available on the inequality within non-monetary outcomes, could be to assume a fixed value for the unobserved correlations between different dimensions. Let $\hat{w}$ denote the synthetic distribution of equivalent incomes obtained when assuming such fixed correlations. Hence, the alternative solution could be to approximate inequality in equivalent incomes as¹⁴

$$I(w) \approx I(\hat{w}). \quad (17)$$

The solution to assume a fixed value for the missing correlation data is assessed by Decerf et al. (2025) in the context of multidimensional poverty measurement. We leave the exploration of this alternative solution in the BGDG framework for future research.

¹⁴One possibility along these lines is to derive two bounds on the inequality in equivalent incomes. The upper bound is obtained by assuming perfect correlations across all dimensions. The lower bound is obtained by assuming independence between all dimensions.

Inequality penalty

Eqs (15) and (16) provide the foundation for an adjustment factor that corrects for income inequality. Formally, we have

$$A_{Ineq} = (1 - I(y)) \quad (18)$$

where I is an inequality index.

This adjustment factor for inequality admits an implicit social weight. This social weight captures aversion to inequality. Indeed, following Atkinson, I should be the inequality index associated by Eq. (14) to the utility function u . Atkinson defines his family of inequality indices from a CES utility function (i.e., isoelastic CRRA)

$$u_\eta(y_i) = \frac{y_i^{1-\eta}}{1-\eta} \quad (19)$$

whose parameter $\eta \geq 0$ captures a constant level of inequality aversion, which leads to a family of inequality indices denoted I_η .

There are different ways in which a value for parameter η can be elicited. One solution is for instance to rely on leaky bucket thought experiments (Pirttilä and Uusitalo, 2010).

It might be worth mentioning a conceptual difference between a preference parameter, like γ_j , and a social weight, like η . A preference parameter captures the trade-off that an individual makes between different dimensions of her wellbeing. In contrast, a social weight captures the trade-off that society makes between the wellbeing of different individuals.

A step-by-step empirical illustration of an indicator obtained by combining adjustment A_{Ineq} with an average-based adjustment $A_{av,j}$ of Section 3 is presented in Appendix 9.3.

5 Poverty and non-monetary deprivation adjustments

This section introduces poverty and non-monetary deprivation as the third pillar of adjustments within our unified framework. This is not merely an extension of the average- and inequality adjustments developed in sections 3 and 4: income poverty and non-monetary deprivation capture a conceptually distinct dimension of wellbeing that is largely absent from existing Beyond GDP indicators, even though it is central to how policymakers and the public assess societal progress. Concretely, in this section we derive two additional types of adjustment factors: a correction for monetary poverty and corrections of non-monetary deprivations. We start with the motivation and the necessary simplifying assumptions and then we present each type of adjustment factor in turn.

Mainstream inequality indices do not capture poverty aversion

Following Atkinson's foundation for an inequality adjustment to mean (equivalent) income (see Section 4), an indicator that represents a SWF cannot combine an inequality adjustment together with a poverty adjustment. The reason is that Atkinson defines inequality as capturing *all* the distributional aspects in $w = (w_1, \dots, w_N)$ that reduce social welfare. We now provide foundations for the use of a poverty adjustment *on top of an inequality adjustment*.

In a nutshell, inequality indices that are used in practice need not capture all the relevant distributional aspects. In particular, they cannot capture all these aspects if society

places a particular emphasis on people falling below some poverty line z . For instance, Atkinson defines its family of inequality indices from a CES utility function u_η (presented in Eq. (19)) whose parameter $\eta \geq 0$ captures the constant level of inequality aversion, which leads to a family of inequality indices I_η defined from Eq. (14). Inequality indices I_η do not treat differently (equivalent) incomes below z because u_η does not either. I_η and more generally all mainstream inequality indices satisfy properties (Scale Invariance or Translation Invariance) which prevent them from providing particular attention below a poverty line. As a result, if society values (equivalent) income changes below z in a different way from changes above z (**assumption 6**), which should be formalized by a “change of regime” for function u at z , then mainstream inequality indices like I_η no longer satisfy the definition proposed by Atkinson, i.e., they violate Eq. (14). We show below that this reasoning provides the foundation for a poverty adjustment on top of an inequality adjustment, where the inequality adjustment is based on a traditional inequality index.

Extending Atkinson reasoning to poverty

We formalize the above reasoning. We consider below the distribution of equivalent incomes (w) rather than that of incomes (y), but the reasoning directly generalizes. Let u_I denote the utility function that provides the foundation for some mainstream inequality index I . Let u_{IP} denote a more general utility function that accounts for both inequality aversion and a form of poverty aversion that is defined as an extra penalty applied to equivalent incomes below the poverty line z (where $z \in \mathbb{R}_+$)

$$u_{IP}(w_i, z) = u_I(w_i) - d(w_i, z) \quad (20)$$

where the continuous function d is such that $d(w_i, z) = 0$ when $w_i \geq z$ and d is decreasing in its first argument below z . A poverty measure can be defined as

$$P(w, z) = \frac{1}{N} \sum_{i=1}^N d(w_i, z) \quad (21)$$

which allows writing a social welfare function SWF_{IP} that accounts for both inequality and poverty as

$$SWF_{IP}(w, z) = \frac{1}{N} \sum_{i=1}^N u_{IP}(w_i, z) = \frac{1}{N} \sum_{i=1}^N \underbrace{u_I(w_i)}_{SWF_I(w)} - P(w, z) \quad (22)$$

where SWF_I denotes the social welfare function associated to utility function u_I . We can directly extend Atkinson’s EDE concept to SWF_{IP} as

$$\tilde{w}_{IP} = u_{IP}^{-1}(SWF_{IP}(w, z)) = u_I^{-1}(SWF_I(w) - P(w, z)) \quad (23)$$

Assuming that $\tilde{w}_{IP} \geq z$, which should hold in societies that are not too poor, we have

$$\tilde{w}_{IP} = u_I^{-1}(SWF_I(w) - P(w, z)) \quad (24)$$

We develop Eq. (24) for the particular case $u_I = u_\eta$ defined in Eq. (19) (**assumption 7**), where η captures inequality aversion. We successively get

$$\begin{aligned}\tilde{w}_{IP} &= \left((1 - \eta) \times \left[SWF_I(w) \times \left(1 - \frac{P(w, z)}{SWF_I(w)} \right) \right] \right)^{\frac{1}{1-\eta}} \\ &= [(1 - \eta) \times SWF_I(w)]^{\frac{1}{1-\eta}} \times \left(1 - \frac{P(w, z)}{SWF_I(w)} \right)^{\frac{1}{1-\eta}} \\ &\approx [(1 - \eta) \times SWF_I(w)]^{\frac{1}{1-\eta}} \times e^{-\frac{1}{1-\eta} \frac{P(w, z)}{SWF_I(w)}} \\ &= \tilde{w} \times e^{-\frac{P(w, z)}{\tilde{w}^{1-\eta}}}\end{aligned}$$

where by definition $\tilde{w} = \left(\frac{1}{N} \sum_i w_i^{1-\eta} \right)^{\frac{1}{1-\eta}} = [(1 - \eta) \times SWF_I(w)]^{\frac{1}{1-\eta}}$ and where the approximation taken is that $(1 - a)^b \approx e^{-ab}$, which holds approximately when $(1 - a)^b \approx 1$.¹⁵ From Eq. (15) we have $\tilde{w} = \bar{w} \times (1 - I_\eta(w))$, so that

$$\tilde{w}_{IP} \approx \bar{w} \times (1 - I_\eta(w)) \times e^{-\frac{P(w, z)}{(\bar{w} \times [1 - I_\eta(w)])^{1-\eta}}} \quad (25)$$

For the special case $\eta = 1$ (**assumption 8**), the former expression further simplifies to

$$\tilde{w}_{IP} \approx \bar{w} \times \underbrace{(1 - I_1(w))}_{\text{Inequality Adjust}} \times \underbrace{e^{-P(w, z)}}_{\text{Poverty Adjust}} \quad (26)$$

where inequality index I_1 is ordinaly equivalent to the mean log deviation and where P is a poverty measure whose poverty score $d(w_i, z)$ captures the additional welfare penalty that poverty imposes over and above inequality aversion $\eta = 1$. From Eq. (26), we see that the Atkinson inequality index associated to u_{IP} is approximatively equal to $1 - (1 - I_1(w)) \times e^{-P(w, z)}$.

We provide an illustration of a CES poverty penalty to CES utility in Appendix 9.4. These CES definitions nicely illustrate the notion of “regime change” at the poverty line and provide a particular expression for the poverty measure in equivalent incomes ($P(w, z)$).

A natural and convenient definition for the poverty penalty

Eq. (26) is based on a poverty measure in equivalent incomes ($P(w, z)$) that is the average of individual penalty functions. We propose a mathematical expression for the penalty function that (i) is natural given our assumptions, (ii) can be applied even when the joint distribution over achievements is not fully observed and (iii) does not exhibit extreme sensitivity to measurement errors.

First, Eq. (26) assumes an aversion to inequality $\eta = 1$, at least for individuals whose equivalent income is above z . The value $\eta = 1$ implies a utility function $u_I(w_i)$ based on logarithms. As a result, it is natural to write

$$u_{IP}(w_i, z) = \ln(w_i) - d(w_i, z) \quad (27)$$

¹⁵Hence, the approximation holds when $\frac{P(w, z)}{\tilde{w}^{1-\eta}}$ is close to zero.

Our assumptions on non-monetary dimensions (see section 3) suggest the following approximate expression for equivalent income (see Eq. (9))

$$w_i \approx y_i \times \prod_{j=1}^J e^{\gamma_j \times (x_{ij} - x_j^*)} \quad (28)$$

Assuming a deprivation cutoff z_j in each non-monetary dimension j , we can thus define

$$z = z_y \times \prod_{j=1}^J e^{\gamma_j \times (z_j - x_j^*)}. \quad (29)$$

where z_y is the monetary poverty line.

Together, Eq. (27) and (28) suggest the following mathematical expression for the poverty penalty function (**assumption 9**)

$$d(w_i, z) = d(y_i, x_i, z_y, (z_j)_{j \in J}) = \alpha \times \left((\ln(z_y) - \ln(y_i)) + \sum_{j \in J} \gamma_j \times (z_j - x_{ij}) \right) \quad \text{if } w_i < z \quad (30)$$

where $\alpha \geq 0$ is the normative weight attributed to the poverty penalty.

As the joint distribution over achievements in different dimensions is typically not fully observed (data constraint), we cannot necessarily tell in the data whether $w_i < z$. Indeed, it can be that individual i is deprived in dimension j , i.e., $x_{ij} < z_j$, but her achievements in other dimensions imply that $w_i \geq z$. To move forward, we henceforth account for all observed deprivations, whether they afflict individuals whose equivalent income is below z or not (**assumption 10**). That is, we approximate Eq. (30) with

$$d'(y_i, x_i, z_y, (z_j)_{j \in J}) = \alpha \times \left((\ln(z_y) - \ln(y_i))^+ + \sum_{j \in J} \gamma_j \times (z_j - x_{ij})^+ \right) \quad (31)$$

where $f^+ = f$ if $f > 0$ and $f^+ = 0$ otherwise. Hence, a high achievement in one dimension can never compensate for a deprivation in another dimension. Assumption 10 and function d' thus encapsulate a “multidimensional” approach to poverty.

Using the approximation $\ln(z_y) - \ln(y_i) \approx 1 - \frac{y_i}{z_y}$, which approximately holds when y_i is close to z_y , we obtain the following approximation for the poverty measure.

$$\begin{aligned} P(w, z) &= P(y_i, x_i, z_y, (z_j)_{j \in J}) \\ &= \frac{1}{N} \sum_{i=1}^N d'(y_i, x_i, z_y, (z_j)_{j \in J}) \\ &\approx \alpha \times PGR(y, z_y) + \sum_{j \in J} \alpha \times \gamma_j \times PG(x_j, z_j), \end{aligned} \quad (32)$$

where the poverty gap ratio is $PGR(y, z_y) = \frac{1}{N} \sum_{i=1}^N (1 - \frac{y_i}{z_y})^+$ and the poverty gap is $PG(x_j, z_j) = \frac{1}{N} \sum_{i=1}^N (z_j - x_{ij})^+$.

We make a few remarks on Eq. (32). First, both PGR and PG are linear in achievements, which implies that they do not have extreme sensitivity to low achievements.¹⁶

¹⁶In contrast, the poverty measure $P_{\eta\epsilon}$ defined in Appendix 9.4 by Eq. (42) is afflicted by an extreme sensitivity to low achievements, which can become an issue in presence of measurement errors at the bottom.

Second, both PGR and PG are relatively easy to communicate. Indeed, they have simple (linear) mathematical expression and intuitive units.¹⁷

Third, the aggregate poverty measure $P(y_i, x_i, z, (z_j)_{j \in J})$ can be computed with data that are collected separately for different dimensions, i.e., when the joint distribution over achievements is not fully observed.¹⁸

Fourth, and most importantly, Eq. (32) together with Eq. (26) provide the foundation for two additional types of adjustment factors: one related to monetary poverty and the other related to non-monetary deprivations.

Non-monetary deprivation penalty

Formally, we get from Eq. (26) and (32) that

$$A_{dep.j} = e^{-\alpha \times \gamma_j \times PG(x_j, z_j)} \quad (33)$$

where γ_j is the weight given to an additional unit of non-monetary outcome j (see Section 3) and the deprivation aversion parameter $\alpha \geq 0$ tunes the additional sensitivity of BGDG to non-monetary outcomes below the deprivation cutoff.

We make a few remarks on Eq. (33).

First, the reduction of the PG by one unit has an impact on BGDG growth that is fixed, i.e., it does not depend on the initial value for the PG. In other words, countries with very high (or very low) PG do not receive a particularly favorable (or defavorable) assessment of a progress by one PG unit.¹⁹

Second, the deprivation aversion parameter has an intuitive interpretation as the additional priority given below cutoff z_j . To see this more formally, assume that average achievement $\bar{x}_j$ increases by one unit. If the improvement is due to progress affecting individuals whose achievement was *above* z_j , then BGDG raises by γ_j percent. If the improvement is due to progress affecting individuals whose achievement is *below* z_j , then BGDG raises by $\gamma_j \times (1 + \alpha)$ percent. Indeed, the latter improvement is reflected through both adjustment factors $A_{av.j}$ and $A_{dep.j}$. The $A_{av.j}$ channel grows BGDG by γ_j percent and the $A_{dep.j}$ channel raises BGDG by $\alpha \times \gamma_j$ percent. This shows that an improvement taking place below z_j has an impact on BGDG that is $(1 + \alpha)$ as large as one taking place above z_j . Thus, α is exactly the additional priority below z_j .

Third, the addition of deprivation adjustment factors $A_{dep.j}$, on top of average adjustment factors $A_{av.j}$, mitigates a limitation of BGDG indicators with only average adjustments factors. Recall that the latter indicators have a fixed marginal rate of substitution between two non-monetary dimensions j and j' equal to $\frac{\gamma_j}{\gamma_{j'}}$. It is no longer the case for BGDG indicators combining $A_{av.j}$ and $A_{dep.j}$. Indeed, when the outcomes in dimensions j and j' respectively change below z_j and above $z_{j'}$ (or the other way around), the marginal rate of substitution can also take values $\frac{(1+\alpha) \times \gamma_j}{\gamma_{j'}}$ and $\frac{\gamma_j}{(1+\alpha) \times \gamma_{j'}}$.

¹⁷ PG is the average shortfall $(z_j - x_{ij})^+$ over the population and thus shares the same units as non-monetary achievement x_{ij} . PGR is the average monetary shortfall $(z - y_i)^+$ relative to z over the population and is thus a ratio of two incomes.

¹⁸A clear limitation is that it is missing the correlation between deprivations. Also, these penalties are linear in the depth of deprivation, which makes them insensitive to how deprivation gaps are distributed across individuals. Yet, for pragmatic reasons, we adopt this linear aggregation in our empirical illustration.

¹⁹The minimal value that $A_{dep.j}$ can take is not zero, but it is rather equal to $e^{-\alpha \times \gamma_j \times z_j}$. Again, one need not fear the fact that BGDG has a multiplicative structure.

Monetary poverty penalty

Formally, we get from Eq. (26) and (32) that

$$A_{pov} = e^{-\alpha \times PGR(y, z_y)} \quad (34)$$

where the poverty aversion parameter $\alpha \geq 0$ tunes the additional sensitivity of BGDG to monetary outcomes below the poverty line.

We make a few remarks on Eq. (34).

First, the reduction of the PGR by one unit has an impact on BGDG growth that is fixed. It does not depend on the initial value for the PGR.

Second, the monetary poverty aversion parameter α is exactly the same as the deprivation aversion parameter. Parameter α tunes the additional priority given below the poverty line z_y . To see this more formally, assume for simplicity that there is no adjustment factor penalizing for inequality ($\eta = 0$). If N currency units are distributed among individuals who are not (monetary) poor, then mean income increases from $\bar{y}$ to $\bar{y} + 1$. Thus, mean income (and thus BGDG) raises by $\frac{1}{\bar{y}}$ percent. If instead these N currency units are distributed among poor individuals, then there are two channels. First, BGDG raises by $\frac{1}{\bar{y}}$ percent, through the mean income channel. But we also need to account for the A_{pov} channel. The poverty gap ratio decreases by an amount $\frac{1}{z}$. From the expression of A_{pov} , this reduction grows BGDG by $\frac{\alpha}{z}$ percent. Together, the two channel leads to a BGDG growth by $\frac{1}{\bar{y}} + \frac{\alpha}{z}$ percent. This analysis shows that increments below z_y have an impact on BGDG that is $(1 + \frac{\bar{y}}{z}\alpha)$ as high as increments above z_y . We thus get that the additional priority given below the poverty line is the product of α and $\frac{\bar{y}}{z}$, where typically $\frac{\bar{y}}{z} \geq 1$.²⁰

Third, the addition of poverty adjustment factors A_{pov} also affects the variety of trade-offs made by BGDG between non-monetary outcomes and monetary outcomes. BGDG indicators with only average adjustments factors only allow for a fixed semi-elasticity for dimension j equal to γ_j . When adding a poverty adjustment A_{pov} and a deprivation adjustment $A_{dep,j}$, semi-elasticities can also take values $(1 + \alpha) \times \gamma_j$ and $\frac{\gamma_j}{(1 + \frac{\bar{y}}{z}\alpha)}$ (assuming again $\eta = 0$), depending on whether outcomes change below or above z_j and z_y .

Selection of poverty line, deprivation cutoffs and parameter α

The implementation of the multidimensional poverty measure $P(y_i, x_i, z_y, (z_j)_{j \in J})$ requires selecting a monetary poverty line z_y as well as deprivation cutoffs z_j in each dimension j . To be sure, these normative choices are arbitrary to some extent. Fortunately, most countries and several international institutions have adopted official monetary poverty lines, which can thus guide the choice of z_y . Also, the literature on multidimensional poverty measurement can provide benchmark values for z_j .

However, $P(y_i, x_i, z_y, (z_j)_{j \in J})$ also requires a value for parameter $\alpha \geq 0$. There exist no benchmark values for parameter α . In Appendix 9.4, we relate parameter α to the concept of inequality aversion (which we assume take two different values, above and below z). By doing so, the range of plausible values for inequality aversion will constrain the plausible range for α . We find that a value $\alpha = 1.5$ is plausible when inequality aversion below z is in the range $[2, 3]$.

²⁰Hence, the additional priority given below the poverty line is larger in countries for which $\frac{\bar{y}}{z}$ is larger, i.e., typically in richer countries.

6 Empirical illustration of BGD

We construct a BGD indicator with four adjustments factors and use it to make cross-country comparisons and assess trends.

It might be useful to spell out what this section aims to achieve and what it does not. The main goal is to showcase how easy it is to analyze and communicate wellbeing comparisons based on a BGD indicator. The section gives a sense of the kind of questions that BGD can address and the type of answers it can deliver.

This illustration shows how one can construct a BGD indicator. However, we do not claim that this particular indicator is “ideal”. Keeping in the agnostic spirit of the BGD framework, we do not wish to defend the particular choice of dimensions or aspect-specific indicators. We strive to make plausible choices and to keep definitions parsimonious. Yet we believe our indicator is interesting in its own right, and we therefore do not refrain from analyzing empirical results.²¹

Definition of our BGD indicator

Our BGD indicator has four adjustment factors. Its income inequality adjustment, denoted A_{Gini} , is based on the Gini coefficient ($Gini$).²² Its adjustment for average non-monetary outcomes, denoted A_{LE} , is based on life expectancy at birth (LE), which reflects average lifespans. Its monetary poverty adjustment, denoted A_{Pov} , is based on the poverty gap ratio (PGR). Finally, its adjustment for non-monetary deprivation, denoted A_{LGE} , is based on deprivation in the lifespan dimension, which is captured by lifespan gap expectancy (LGE), namely the number of years of life a newborn expects to prematurely lose, where premature mortality is defined based on an age threshold.²³

Our BGD indicator is defined as follows

$$BGDP = GDP \times \underbrace{\frac{(1 - Gini)}{(1 - Gini^*)}}_{A_{Gini}} \times \underbrace{e^{\gamma_{LE} \times (LE - LE^*)}}_{A_{LE}} \times \underbrace{e^{-\alpha \times (PGR - PGR^*)}}_{A_{Pov}} \times \underbrace{e^{-\alpha \times \gamma_{LE} \times (LGE - LGE^*)}}_{A_{LGE}} \quad (35)$$

where GDP denotes GDP per capita. Our BGD indicator does not include a pass-through $A_{PT} = \frac{\bar{y}}{GDP}$, not because we deem GDP an appropriate measure of average income, but rather because we are still collecting the necessary data for $\bar{y}$. The reference values used for normalization purposes – $Gini^*$, LE^* , PGR^* and LGE^* – do not affect comparisons. Yet, BGD admits two weights, namely γ_{LE} and α , whose values must be carefully selected as they affect comparisons.

First, γ_{LE} denotes the weight given to an extra year of life. More precisely, γ_{LE} captures the percentage of their income that people are willing to give up to gain one

²¹To be sure, several empirical findings will be reminiscent of those from other conceptually-grounded indicators, e.g., [Fleurbaey and Gaulier \(2009\)](#); [Jones and Klenow \(2016\)](#); [Boarini et al. \(2022\)](#). Our illustration demonstrates that they can be established with a simple indicator.

²²We use the Gini coefficient instead of the Atkinson inequality index for $\eta = 1$, which is a departure from the theory. We do this for communication purposes. Empirically, Gini might be closer to the Atkinson inequality index for $\eta = 1.5$.

²³More formally, the lifespan gap expectancy is defined as $LGE = \sum_{a=0}^{z_{LE}-1} (z_{LE} - (a + 1)) \times \mu_a \times \prod_{k=0}^{a-1} (1 - \mu_k)$, where μ_a and μ_k capture age-specific mortality rates (at ages a and k) and z_{LE} is the age threshold for premature mortality. That is, LGE corresponds to the poverty gap for the lifespan dimension; when defined based on mortality tables.

additional year of life. We assume $\gamma_{LE} = 0.05$, i.e., 5 percent, which is consistent with the results from [Murtin et al. \(2017\)](#).

Second, α denotes the additional priority given to poverty and deprivation. As explained in [Appendix 9.4](#), we select $\alpha = 1.5$. This value implies that an increase in life expectancy by one year that comes from improvements below the premature mortality threshold, BGD_P raises by 12.5 percent ($= (1 + \alpha) \times \gamma_{LE}$, as explained in [Section 5](#)).

There are three additional normative choices that are worth mentioning. First, we use the Gini coefficient because it is a mainstream inequality index. Gini is not based on a fixed value for inequality aversion η , but empirically roughly corresponds to $\eta \approx 1.5$.

Second, the age threshold defining premature mortality is taken to be 40 years, which corresponds to that considered by the Human Poverty Index ([Watkins, 2006](#)).

Third, the monetary poverty line is taken to be the higher global poverty line considered by the World Bank, which corresponds to the typical poverty line among upper-middle income countries. Its threshold is 8.3 \$ per person per day in 2021 PPPs. This is an *absolute* poverty line. We provide in [appendix 9.6](#) robustness results for an alternative definition of the poverty line, which is an anchored country-specific poverty line defined from the Societal Poverty Line (SPL) proposed by [Jolliffe and Prydz \(2021\)](#).²⁴

The definition of BGD_P implies that trend analysis over a period $t - t'$ can be decomposed into five components as follows:

$$\begin{aligned}
 BGD\ P\ growth \approx & \underbrace{\ln\left(\frac{GDP'}{GDP}\right)}_{\sim GDP\ growth} + \underbrace{\ln\left(\frac{(1 - Gini')}{(1 - Gini)}\right)}_{change\ in\ Gini} + \underbrace{\gamma_{LE} \times (LE' - LE)}_{change\ in\ LE} \\
 & - \underbrace{\alpha \times (PGR' - PGR)}_{change\ in\ PGR} - \underbrace{\alpha \times \gamma_{LE} \times (LGE' - LGE)}_{change\ in\ LGE}
 \end{aligned} \tag{36}$$

Data sources and sample of countries

BGD_P has three factors related to the monetary dimension, namely GDP , A_{Gini} and A_{Pov} . The monetary data is taken from the World Bank. In particular, the GDP data comes from the World Development Indicators. The Gini coefficient and the poverty gap ratio is taken from the Poverty and Inequality Platform, which draws on national household surveys, with income or consumption aggregates.

BGD_P has two factors related to the lifespan dimension, namely A_{LE} and A_{LGE} . The mortality data is taken from Global Burden of Disease.

From these databases, we can compute results for 131 countries, which together host 7.2 billion people, thus accounting for 90 percent of the World's population in 2023. We have data from 1990 to 2023. For long-term wellbeing trend over the period 1990-2023, we interpolate and extrapolate the missing income inequality data. We describe the procedure used to construct our sample of countries and compute our estimates in [Appendix 9.5](#).

²⁴There is no consensus on how to define a global monetary poverty line ([Decerf, 2025](#)). This problem is compounded when comparing a very diverse set of countries. An absolute poverty line uses the same standard for all countries. However, an absolute line is bound to be irrelevant for some countries. Either almost all the population is poor in low income countries, or almost all the population is non-poor in high income countries. A country-specific poverty line avoids this irrelevance issue. However, the fact that its poverty standard is country-specific must be kept in mind when comparing results across-countries. To avoid potential confusion, we sometimes denote BGD_P as either $BGD\ P_{Abs}$ or $BGD\ P_{SPL}$ to refer to its underlying notion of poverty.

The reference values for normalization purposes are taken to be the median values for our sample of countries in 2023, namely $Gini^* = 0.35$, $LE^* = 73.3$ years, $LGE^* = 0.96$ years and $PGR^* = 0.11$.

Cross-country comparisons in 2023

Table 1 provides BGD_P values for a sample of countries in 2023, ordered by GDP per capita. These results illustrate a couple of points.

First, cross-country differences in BGD_P are larger than cross-country differences in GDP alone. More precisely, richer countries tend to have a larger BGD_P value than their GDP value, while the reverse holds in poorer countries. The reason is the positive correlation between GDP and adjustment factors A_{LE} , A_{Pov} and A_{LGE} . Richer countries tend to have longer life expectancy, less poverty and less lifespan deprivation.²⁵

Second, the adjustment factors lead to rank-reversals among countries. This is for instance the case between Pakistan and Nigeria, or between Indonesia and South Africa. BGD_P's multiplicative decomposition directly points to the origin of these reversals. Adjustment factors are directly comparable across countries: a larger value implies a better value for the aspect considered. For instance, although South Africa has a larger GDP per capita than Indonesia, Indonesia performs better than South Africa in all four adjustment factors. Eyeballing their respective columns suggests that A_{Gini} has the largest impact for their rank-reversal.

Third, there are no rank-reversals between countries that have very different GDP values. This is because adjustment factors tend to be positively correlated with GDP (except for Gini) and adjustment factors tend to take values between 0.5 and 1.5.

Cross-country comparisons in 2023: contrasting adjustment factors

Next, we illustrate the values of the four different adjustments factors in Figure 1. This figure reveals the role that each of these adjustment factor plays. This figure takes advantage of the multiplicative structure of BGD_P (and to some extent, of its normalization).

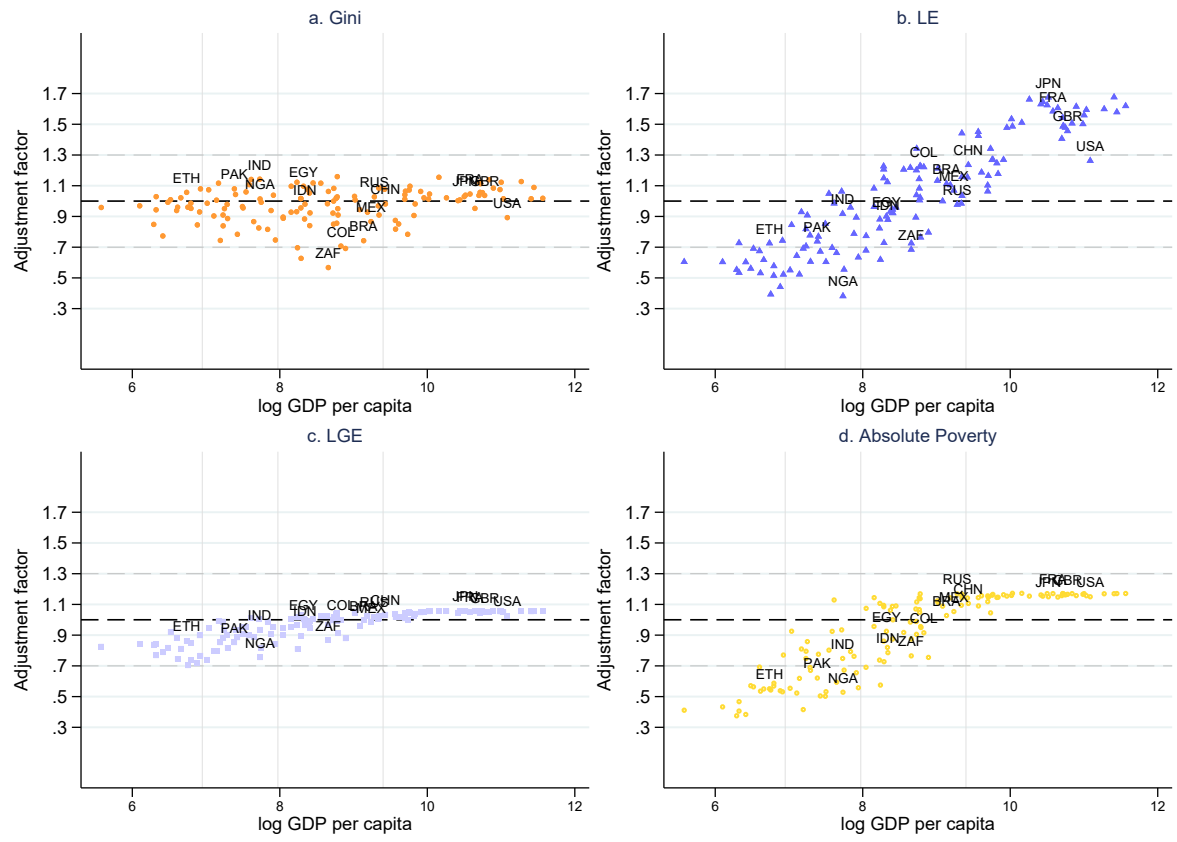
Two aspects matter. First, the more tightly clustered around 1 is the scatter plot associated to an adjustment factor, the smaller is the impact of this adjustment factor on BGD_P, i.e., on the difference in BGD_P values across rich and poor countries. For instance, A_{LE} plays a much larger role than A_{LGE} . Similarly, A_{Pov} plays a much larger role than A_{LGE} . Of course, this first aspect is sensitive to the values selected for the weights (γ_{LE} , α and η).

Second, the more dispersed is a scatter plot at any given GDP level, the more numerous the rank-reversals that its associated adjustment factor generates at this GDP level. For instance, A_{Pov} and A_{LGE} are dispersed among low-income countries (LICs) and lower-middle-income countries (LMICs), but not dispersed at all among high-income countries (HICs). The reason is that all HICs have virtually zero poverty or lifespan deprivation.

Figure 1 thus suggests that A_{LE} is the most consequential adjustment factor for BGD_P comparisons, while A_{LGE} is the least consequential one. Also, the poverty and deprivation adjustments do not discriminate much among rich countries. However, these two adjustments have more discriminative power among non-HICs countries, especially so for A_{Pov} .

²⁵Gini is not as much correlated with GDP.

Figure 1: Adjustment factors for BGD_P as function of log GDP in 2023



Notes: Reference values are $GDP^* = \$5688$ per person per year, $Gini^* = 0.35$, $LE^* = 73.7$ years, $LGE^* = 0.96$ years and $PGR_{Abs}^* = 0.11$.

Table 1: Cross-country comparisons in 2023 with BGDP.

Country	GDP (\$ a yr)	BGDP (\$ a yr)	Gini (-)	A_{Gini} (-)	LE (yrs)	A_{LE} (-)	PGR (-)	A_{Pov} (-)	LGE (yrs)	A_{LGE} (-)
Ethiopia	842	307	0.31	1.06	67	0.73	0.5	0.55	2.9	0.86
Pakistan	1610	679	0.30	1.08	68	0.74	0.42	0.62	3.1	0.85
Nigeria	2281	352	0.34	1.01	54	0.38	0.53	0.53	4.7	0.76
Indonesia	4193	2736	0.36	0.98	71	0.88	0.27	0.79	1.5	0.96
South Africa	5757	1484	0.63	0.57	66	0.68	0.28	0.77	2.9	0.87
Brazil	9288	7859	0.52	0.74	76	1.11	0.09	1.03	1.0	1.00
Mexico	10259	9872	0.44	0.87	75	1.07	0.07	1.05	1.2	0.98
China	12484	17326	0.36	0.98	78	1.24	0.04	1.11	0.5	1.03
Japan	36953	78229	0.32	1.04	84	1.68	0.01	1.15	0.2	1.06
France	39319	80195	0.32	1.05	83	1.58	0.00	1.17	0.3	1.05
United States	65187	86631	0.42	0.89	78	1.26	0.01	1.15	0.6	1.03
Median LIC	736	170	0.37	0.96	64	0.60	0.51	0.54	3.5	0.83
Median LMIC	2166	949	0.38	0.95	69	0.78	0.30	0.75	1.9	0.93
Median UMIC	6449	6722	0.36	0.98	74	1.04	0.06	1.07	0.9	1.01
Median HIC	34240	72218	0.32	1.04	82	1.49	0.01	1.16	0.3	1.05

Note: Monetary amounts are expressed in 2021 PPPs. Reference values are $Gini^* = 0.35$, $LE^* = 73.7$ years, $LGE^* = 0.96$ years and $PGR^* = 0.11$. Median values are computed for each column separately. This implies that median value for BGDP is not equal to the product of median values of its factors.

Decomposition of BGDP level in 2023

Figure 2 investigates which of the five factors plays the main role in the value taken by BGDP, starting from a reference society in which all factors take the median value the 131 countries in 2023 – $GDP^* = \$5688$ per person per year, $Gini^* = 0.35$, $LE^* = 73.3$ years, $LGE^* = 0.96$ years and $PGR^* = 0.11$ – and using Eq. (36).

For instance, to reach the level of Ethiopia’s BGDP (black dot), all factors except A_{Gini} must be reduced with respect to their reference values. The two factors that must be most reduced are GDP and A_{Pov} . This figure suggests that GDP plays the dominant role in BGDP levels, which is confirmed by Figure 18 which plots all 131 countries.

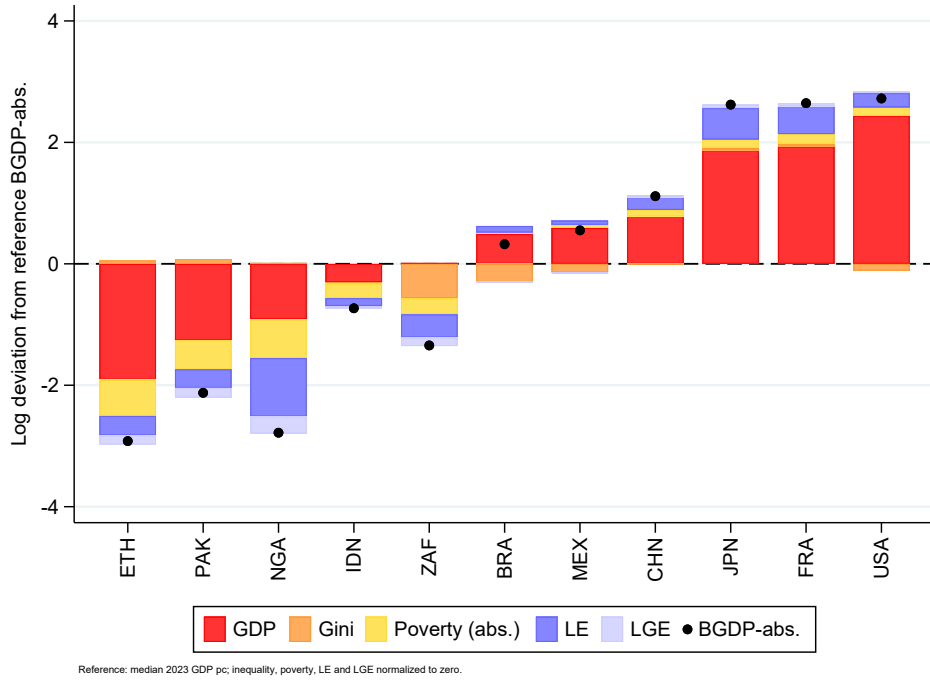
Rank-reversals in 2023 : quantification and main sources

We explore rank-reversals in Figure 3. The red bars in the figure show, for different sample of countries, the probability that two countries drawn at random are ranked differently by GDP and BGDP. In turn, the orange bars show the probability that two countries drawn at random are ranked differently by GDP and $GDP \times A_{Gini}$. Hence, non-red bars help investigate which of the four adjustment factors plays a larger role in these rank-reversals.

First, rank-reversals between GDP and BGDP are scarce when comparing countries with very different GDP levels. As shown by the red bars, there are about 5 percent rank-reversals in the full sample and among HICs. The percentage of rank-reversals increases around 15 to 20 percent among LICs, LMICs and UMICs.

Second, the adjustment factor that is most consequential in terms of rank-reversal depends on the level of GDP. Among LICs, A_{LE} is the most consequential (dark blue bars). Among LMICs, A_{Pov} (yellow bars) is as consequential as A_{LE} . Among UMICs,

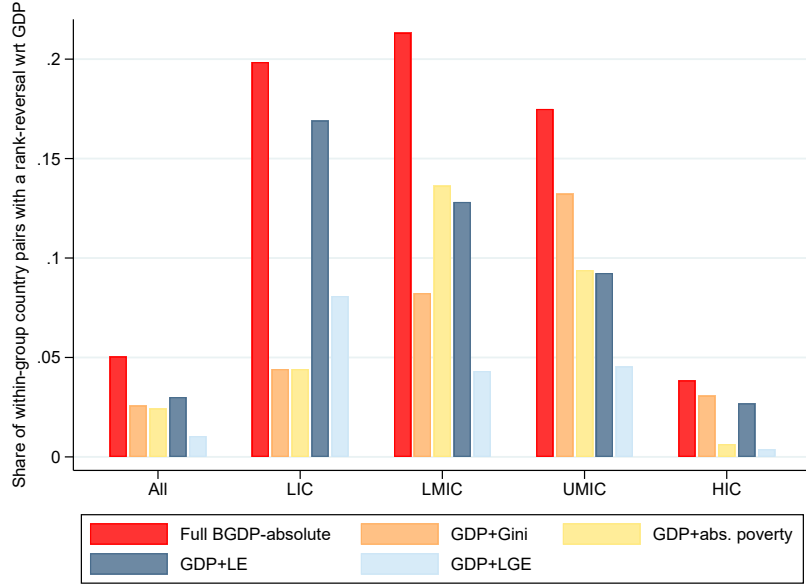
Figure 2: Decomposition of BGD level for selected countries



Notes: The figure decomposes the BGD change that would be necessary to move from the reference society to the level of BGD in each country. The reference society has all its factors to their reference levels, so that $BGD^* = GDP^* \times 1 \times 1 \times 1 \times 1 = GDP^*$ where GDP^* is the median value for GDP per capita in 2023. Reference values are $GDP^* = \$5688$ per person per year, $Gini^* = 0.35$, $LE^* = 73.7$ years, $LGE^* = 0.96$ years and $PGR_{Abs}^* = 0.11$.

A_{Gini} is the most consequential (orange bars).

Figure 3: Cross-country rank-reversals with respect to GDP in 2023



Notes: The figure shows the share of within-group country pairs for which there is a rank-reversal between GDP and an alternative wellbeing indicator. GDP+Gini, GDP+LE, GDP+Pov and GDP+LGE are respectively defined as $GDP \times A_{Gini}$, $GDP \times A_{LE}$, $GDP \times A_{PGR}$ and $GDP \times A_{LGE}$.

Trends : the Covid-19 shock

Figure 4 shows the decomposition of the Covid-shock-related BGDp change (Eq. (36)).

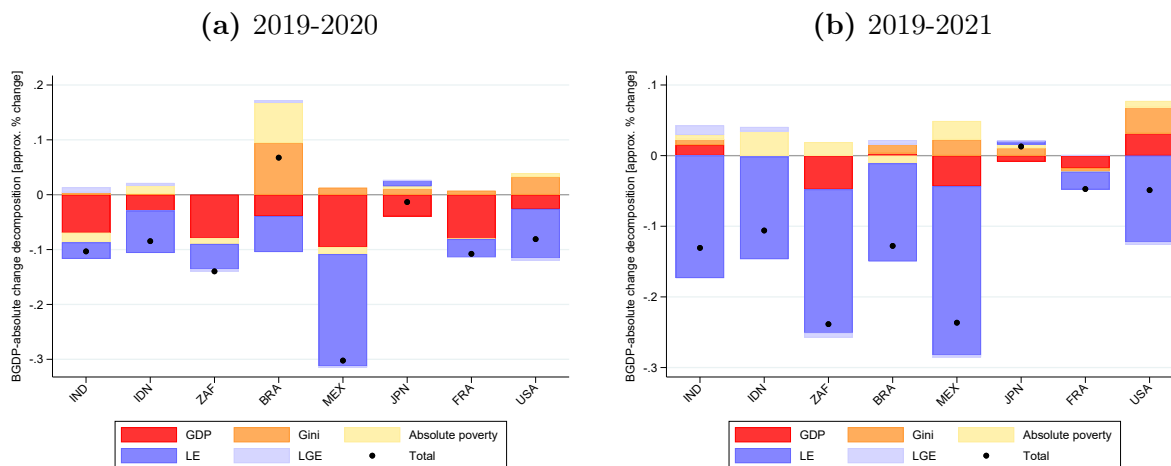
BGDp indicators allow for simple trend analysis. Take the decomposition of the BGDp change in the US over 2019-2020 (left panel of Figure 4). BGDp falls by about 8 log points, which is the sum of the contributions from all factors, namely GDP -2.6 log points, A_{LE} -9, A_{Gini} +4 (A_{Pov} and A_{LGE} have smaller impacts). Roughly, this decomposition shows that BGDp decreased by about 8 percent because GDP decreased by 2.6 percent, the life expectancy factor (A_{LE}) decreased by 9 percent and the inequality factor (A_{Gini}) improved by 4 percent (where $8 \approx 2.6 + 9 - 4$). The decomposition thus shows that life expectancy plays the dominant role for BGDp change in the US over 2019-2020. Life expectancy's impact on BGDp has been more than three times larger than GDP's impact on BGDp.

One can easily assess how the decomposition would change under a different weight γ_{LE} . The contribution of life expectancy is proportional to γ_{LE} , so a value of 0.075 instead of 0.05 would make the life expectancy and lifespan gap expectancy bars 50 percent longer. Similarly, the poverty and deprivation bars are proportional to the value selected for α .

Figure 5 illustrates two main findings. First, as expected, in most countries the Covid shock reduces BGDp, because life expectancy fell with the shock, as did GDP, at least in 2020. Second, countries had very heterogeneous experiences: the intensity of the shock on the different factors is heterogeneous, and even its direction can differ across countries. Contrast for instance Mexico and Japan. Mexico saw BGDp fall by 30 log points, of which 20 came from life expectancy and 10 from GDP, while Japan fell by only 1 log points – and all adjustments factors slightly improved, partly offsetting a GDP fall of 4

log points. Strikingly, the social protection program enacted by Brazil in 2020 was large enough to more than offset the negative impact of mortality on BGD. Indeed, it is not only inequality but also poverty that was improved.

Figure 4: Impact of covid-shock on BGD over 2019-2021



Notes: The figure shows the decomposition of BGD change across all BGD factors (log units).

Trends : progress over three decades, selected countries (1990-2023)

Figure 5 shows the progress over the last decades for a sample of populous countries.

We start with a word of caution. Because BGD values have changed so much for most of these countries, we cannot interpret their value for BGD change as the growth in their BGD value. Log units no longer approximate percentage change well beyond 0.2 – i.e., beyond 20 log points.

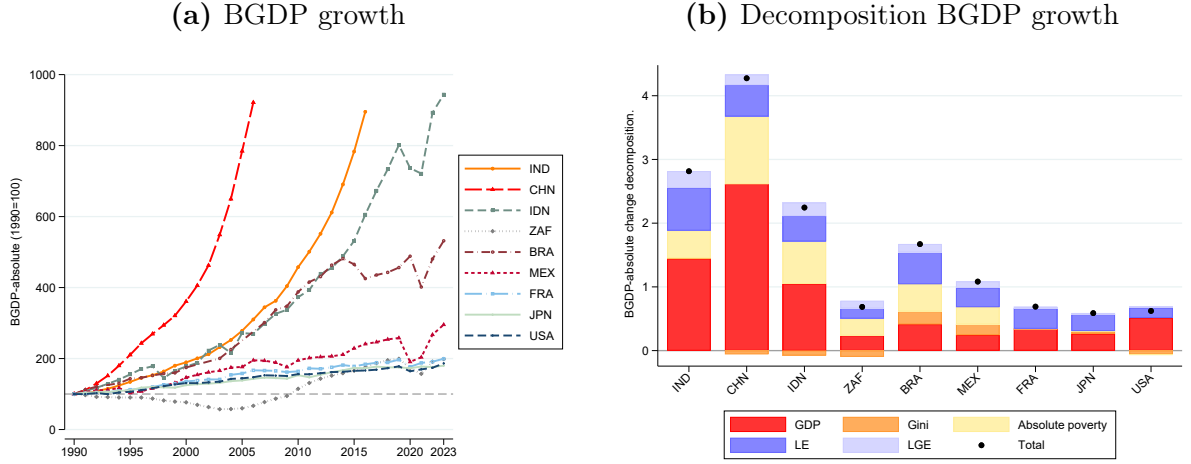
Three main findings are illustrated in Figure 5. First, the amount of progress is very heterogeneous across countries – BGD rose more than 70-fold in China over 1990-2023 against a mere doubling in South Africa – and progress tends to be larger for countries that were initially poorer, as illustrated by India, China and Indonesia. Second, BGD captures more progress than GDP alone, mostly because there has also been significant improvements in life expectancy and poverty reduction. Third, the decomposition reveals which factor plays the larger role: in poorer countries that experienced high GDP growth, like India and China, that factor played the dominant role, while in richer countries like France improvements in life expectancy had an impact similar to GDP growth.

Trends : progress over three decades, country-income groups (1990-2023)

We conclude by examining how progress differs across country-income groups, fixing the composition of these groups to what it was in 1990. BGD is not subgroup decomposable, so for each year we compute BGD at group level from the value of its factors at group level.

Two main findings emerge from Figure 6. First, BGD captures more progress over 1990-2023 than GDP alone. Second, BGD reveals more catching-up by poorer countries than GDP alone: differences have narrowed across country-income groups more than differences in GDP, because improvements in life expectancy and poverty reduction have been larger in poorer groups. This is particularly striking when comparing upper

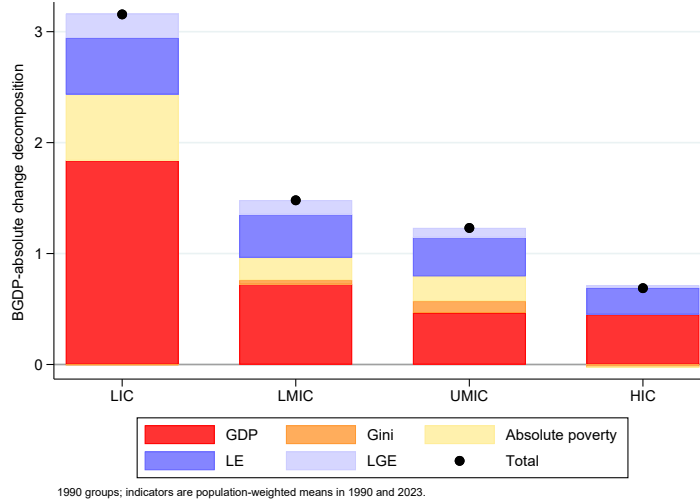
Figure 5: BGD extended progress over 1990-2023 for select countries



Notes: The left panel shows BGD growth when normalizing BGD to its 1990 value. The right panel shows the decomposition of BGD change across all BGD factors (log units).

middle-income and high-income countries, which have similar GDP growth but where the former show larger BGD growth. Observe in particular that the poverty and deprivation adjustment factors allow emphasizing the poverty reduction achieved by developing countries. Adjustment factors A_{Pov} and A_{LGE} account for most of the difference between upper middle-income and high-income countries' BGD changes.

Figure 6: Decomposition of BGD change between 1990-2023 by country-income groups



Notes: The figure shows the decomposition of BGD change across all BGD factors (log units). For the whole period, countries are classified across country-income groups based on their 1990 classification. For each country-income group and each year, the value of Gini, life expectancy and lifespan gap expectancy is approximated by its population-weighted average value in the group.

7 Relationships with selected indicators

In this section, we discuss the relationships and main differences with a few “high profile” summary indicators of wellbeing. We first examine the relationship of our approach to

direct precursors (7.1), and then briefly situate the approach among the larger set of “beyond GDP” indicators.

7.1 Equivalent income precursors

Three papers are direct precursors of our work: [Fleurbaey and Gaulier \(2009\)](#), [Jones and Klenow \(2016\)](#) and [Boarini et al. \(2022\)](#). They will be referred to as FG09, JK16 and BFM22 in this section.

FG09 and BFM22 focus on income whereas JK16 focus on consumption. FG09 and BFM22 compute an equivalent income in monetary units as we do here, whereas JK16 measure well-being in a country by the scaling parameter that would need to be applied to consumption in the reference country (the US in their paper) for it to be as well off as that country. Formally, they solve the equation

$$U_{US}(\lambda_i) = U_i(1),$$

where $U_i(\lambda)$ measures the utility of a representative agent in country i when consumption over life is multiplied by λ .²⁶

The three papers start from a lifetime utility model that aggregates flow utility over life. However, FG09 and BFM22 use current per capita income as a proxy for permanent income, whereas JK16 use life tables and microdata to take account of the profile of consumption and survival at different ages. In absence of life tables, FG09 assume that longevity is, for all individuals, equal to life expectancy in good health, whereas BFM22 assume a constant mortality hazard over life calibrated by life expectancy. All three papers only compute expected utility at birth and do not correct social welfare for ex post inequalities due to differential longevity among individuals, whereas in this paper, the deprivation in longevity for individuals suffering from premature deaths induces a penalty on social welfare.

The adjustment factors differ across the three papers, as depicted in Table 2, where the approach followed in this paper is also featured for comparison.

Both FG09 and BFM22 allow for heterogeneous preferences, whereas JK16 apply the same utility function (estimated on US data) to all countries. While FG09 consider a single representative agent for adjustments, allowing preferences for leisure (proxied by wages) to vary across countries, BFM22 use microdata (with income and unemployment status at the individual level) and allow preferences for average income in the country (a proxy for amenities linked to the level of development) to vary at the socio-demographic group level. Household composition is taken into account in FG09 and BFM22 by relying

²⁶They also propose to consider the alternative equation $U_{US}(1) = U_i(1/\lambda_i)$, but do not notice that in this case, λ_i is not monotonic in the country utility when life expectancy changes. More specifically, the initial formula for λ_i is

$$\log \lambda_i = \frac{\sum_a \beta^a (S_a^i u_a^i - S_a^{US} u_a^{US})}{\sum_a \beta^a S_a^{US}}$$

where a is age, β a discount factor, S_a^i the survival rate at age a , u_a^i the flow utility at age a . This formula is monotonic in $\sum_a \beta^a S_a^i u_a^i$. The alternative formula instead implies

$$\log \lambda_i = \frac{\sum_a \beta^a (S_a^i u_a^i - S_a^{US} u_a^{US})}{\sum_a \beta^a S_a^i}$$

which is not monotonic in $\sum_a \beta^a S_a^i u_a^i$ because the denominator depends on life expectancy in country i .

Table 2: Adjustment factors in the three papers

FG09	JK16	BFM22	This paper
• life expectancy	• life expectancy	• life expectancy	• life expectancy
• working hours	• working hours	• individual unemployment status	• income inequality
• unemployment risk	• inequality in consumption	• unemployment in the country	• income poverty
• household composition	• inequality in leisure	• income in the country	• deprivation in longevity
• inequality in income		• household composition	
		• income inequality	

on equivalised income, whereas JK16 divide household consumption by the number of members.

None of these three papers obtain a simple multiplicative adjustment structure as in our approach. Individual utilities are defined as follows in the three papers, and a star marks the terms that are allowed to vary across countries or socio-demographic groups:

FG09 $E \sum_{a=0}^L \beta^a u(y_a) - w^*(\ell)$ where L is healthy life expectancy, β the discount factor, $u(\cdot)$ is a CRRA function, y is current equivalised income (proxying for equivalised income at age a), and w the disutility of (current) working hours ℓ (the slope of w is estimated by the average wage rate in the country);

JK16 $E \sum_{a=0}^{100} \beta^a S_a [\bar{u} + ga + \log(c_a) - w(\ell_a)]$, where S_a is the survival rate at age a , $\bar{u}$ is an intercept, g is the growth rate of consumption (assumed to affect all age groups uniformly and be the same in all countries),²⁷ c_a is per capita household expenditure at age a , and ℓ_a working hours at age a ;

BFM22 $L [\bar{u} + \alpha \log y + \gamma^* \log \bar{y} + \mu U + \nu \bar{U}]$, where $\bar{y}$ is average income, U is a dummy for unemployed status, and $\bar{U}$ the unemployment rate in the country (the coefficient γ contains interaction terms with socio-demographic characteristics);

This paper $\log y + \gamma L$, where L is life expectancy.

The calibration of these functions relies on various estimates from the literature in FG and JK (such as the VSL for the intercept $\bar{u}$, the wage rate and elasticity of labor supply for the w function, the unemployment rate for the risk of unemployment), and on a life satisfaction regression in BFM.

In this paper, in contrast to these earlier papers, the list of adjustments is small, due to data limitations and in view of our primary objective which is to illustrate the approach rather than fully developing it. Nevertheless, we introduce a new type of adjustment relative to poverty, in addition to inequality.

²⁷This term captures the fact that in a given year, those who are born that year face unequal prospects of consumption at future ages due to growth, e.g., they will have enjoyed less growth at age 30 than at age 50.

7.2 Other approaches

Composite indices

Composite indicators aggregate domain indicators. Prominent examples nowadays include the Human Development Index (HDI) and the Social Progress Index (SPI). In both cases, the domain indicators are normalized and then aggregated with equal weights. In the case of the HDI, the three domain indicators (income, education, longevity) are normalized on the 0-1 scale by picking a maximal and minimal value, and after normalization, the domain indicators are aggregated with equal weights (additively in the former HDI, and multiplicatively since 2010 ([Klugman et al., 2011](#))). The SPI aggregates twelve domain indicators with equal weights in an additive fashion, and these domains fall into three categories: basic human needs (nutrition and basic medical care, water and sanitation, shelter, personal safety), foundations of well-being (access to basic knowledge, access to information and communication, health and wellness, environmental quality), and opportunity (personal rights, personal freedom and choice, inclusiveness, access to advanced education). Each of the twelve domain indicators is made up of three to six variables, which are weighted using principal component analysis.

The key difference between composite indicators and social welfare grounded approaches is that composite indicators are not related to a concept of individual well-being (which is aggregated over the population in the latter approach). The domain indicators are themselves summaries of the situation of the population or descriptions of institutions (for instance, public sector corruption is one of the basic variables in the SPI), and there is no direct conceptual link with how individuals fare when taking all dimensions together.

A key consequence of the absence of a relation between composite indices and a comprehensive notion of well-being at the individual level is that population values and preferences cannot guide the choice of domains and the calibration of weights for the aggregation over domains. This is why one resorts to equal weights or to weights capturing the variance and correlation of the variables. This has been strongly criticized for failing to capture the crucial normative dimension of the weights, and [Ravallion \(2012\)](#) famously pinpointed the questionable trade-offs between life and income in various countries in the HDI.

On the other hand, composite indicators offer complete flexibility in the selection of domains and are easy to explain when they take the form of an arithmetic or a geometric mean. The OECD proposes eleven life domains and does not propose a particular weighting system but lets the visitors of its website experiment with different weights and see the consequences of such experimentation on the relative positions of countries.

In conclusion, with composite indicators, the lack of an individual welfare foundation makes it possible to select domain indicators based on intuition and to adopt simple aggregation methods that are easy to communicate. But easy communication does not imply that users understand the consequences of such indicators for the trade-offs between dimensions and the possible mismatch with the values and preferences of the populations.

Counting measures

Counting measures have been rare in this domain, but the Multidimensional Poverty Index (MPI), a companion index to the HDI in Human Development Reports, has been a prominent example. It is based on counting deprivations at the individual level and

computing a score of deprivation for individuals who are deprived in sufficiently many dimensions, in the form of a weighted sum of the dummy²⁸ variables of deprivation in different dimensions.²⁹ More recently, [Alkire and Kovesdi \(2020\)](#) have proposed a well-being adaptation of this counting methodology. Their approach involves determining sufficiency thresholds in many objective and subjective variables, and computing the weighted average of the dummy variables of sufficiency over the whole population, with a specific adjustment for the individuals with 3/4 or more of the maximal score, for whom the score is put at the maximum for the computation. In their approach, the weights assigned to the dimension indicators rely on expert judgment.

Unlike the composite indicators, this type of counting measure can be linked to social welfare foundations, with two specific features. First, individual well-being is computed with dichotomous variables rather than continuous variables. Second, the aggregation of these variables at the individual level is made with a linear type of aggregation, except for the top coding of individuals with a high level of achievement. Compared to our approach, there are therefore two key informational razor cuts in the counting measures : first, the variables measuring dimensions of life are dichotomized, and second, individuals with certain levels of well-being see their score put at a boundary level. The latter operation may or may not be considered part of the counting approach in general. In the MPI, it may have felt natural to exclude the individuals with just a few deprivations from poverty (which is equivalent to putting their deprivation levels to zero in all dimensions, as well as their overall deprivation score). In the well-being adaptation of the approach, the “sufficiency” lens adopted by [Alkire and Kovesdi \(2020\)](#) may similarly justify the top coding of the well-being scores of individuals who are below sufficiency in less than a fourth of the dimensions. One can imagine other forms of counting measures for which excluding some individuals with sufficiently high or low scores is less justified.

Subjective wellbeing

Subjective well-being (or reported well-being) approaches rely on questionnaires that ask three types of questions: evaluative questions about life satisfaction in general; questions about emotions (to construct a hedonic score); questions about purpose and meaning (to construct a “eudaimonic” score). The questions are simple, generate quick responses, and reveal important information about how people feel.

The crucial question is then whether such scores, in particular the life satisfaction score, can be used as measures of individual well-being without any statistical treatment. Such questions arise with all self-reported scores in any domain. For instance, there is a classical worry in health economics about self-reported health, and it is commonplace in that field to replace the raw health scores with imputed scores based on econometric regressions of the self-reported scores on objective health variables. In this way, differences in scoring behaviors are eliminated, but individual variations in the relative importance of health variables is also erased, as well as the health aspects which are not recorded in the questionnaires.

Heterogeneous scaling behavior has been highlighted as a serious issue in [Graham \(2012\)](#) and more recently documented across individuals in [Benjamin et al. \(2023\)](#), leading

²⁸A dummy variable is equal to 1 in the relevant case—i.e., the person is deprived in the dimension considered—and 0 otherwise

²⁹[Decerf \(2023\)](#) studies formally the relationships between counting multidimensional poverty measures, like the MPI, and preference-based multidimensional poverty measures.

to the conclusion that inequalities in life satisfaction are not as large as in the raw scores, and across periods of time in [Prati and Senik \(2026\)](#) where it is shown that people adjust their scales upward as their situation improves, so much so that people constantly report on average that their situation has improved while their level of satisfaction on average remains quite stable. Such studies confirm the widespread skepticism about the comparability of self-reported scores across individuals (or social or cultural groups) and over time that motivated the philosophical literature on egalitarian justice to reject subjective approaches ([Rawls, 1997](#); [Dworkin, 2002](#)).

In spite of these issues, it is clear that self-reported scores do capture stark differences in living conditions and, in particular, do reflect acute misery. Moreover, with suitable data at the individual level (in particular, panel data), the regression of life satisfaction scores over objective living conditions (such as health, quality of institutions, quality of the environment, etc.) provides relative coefficients for the various domains of life, which may be considered relevant. It is a leap of faith to treat them as preference coefficients because these regressions are plagued by noise in the variables (in particular, income), omitted variables, and reverse causality. Nevertheless, for lack of more direct information about preferences, they may provide fallback options for estimating the relative importance of life domains in individuals' lives.

Compared to our approach, life satisfaction scores suffer from subjective scale use heterogeneity, but on the other hand they capture all aspects of life that each individual deems relevant to include in the assessment. Studies (e.g., [Decancq and Neumann \(2014\)](#)) that show little correlation between indicators which, like ours, involve only a few dimensions of life, and self-reported satisfaction can then be interpreted as showing that life satisfaction is too noisy or that the other indicators are too incomplete, or, more plausibly, that both issues coexist.

Extended preferences

Matthew Adler (see [Adler and Fleurbaey \(2016\)](#), [Adler \(2019\)](#), and [Adler and Norheim \(2022\)](#)) has been a leading advocate of reviving the old idea ([Luce and Raiffa, 1957](#); [Harsanyi, 1976](#); [Dhillon and Mertens, 1999](#)) of using suitably normalized Von Neumann-Morgenstern (VNM) utilities as the measure of well-being to be put into a social welfare function.

The question of the normalization is not easy because it crucially influences interpersonal comparisons.³⁰ The traditional approach to normalizing VNM utilities is to put them into a 0-1 scale, with 0 for a “worst” option and 1 for a “best” option, and this has long been operationalized in surveys using the “standard gamble” in health economics. The standard gamble method asks respondents to pick the probability value that would make them indifferent between a particular situation and a lottery giving the best option with that probability and the worst option otherwise. It is then apparent that with this normalization, VNM utilities are measured in probabilities. Adler has instead suggested to assign value 1 to a sufficiency threshold.

Compared to our approach, there are two key similarities and one key difference. First, both approaches are grounded in social welfare theory and involve computing social welfare by aggregating individual well-being. Second, both approaches are preference-based and satisfy the property that two individuals with exactly the same preferences

³⁰On this issue, see [Fleurbaey and Zuber \(2021\)](#).

will have their ranking coincide with their own views of their relative situations.³¹

The key difference between our approach and VNM utilities is that our approach does not depend on risk attitudes, whereas the VNM utilities embody individuals' risk preferences. There are pros and cons. For the evaluation of final situations involving no risk, as we do in our paper, it may seem odd to have to estimate risk attitudes and make interpersonal comparisons depend on these. On the other hand, VNM utilities carry a pattern of diminishing marginal utility that is absent from equivalent incomes, and this is often cited by Adler as a key advantage. However, one can simply consider that inequality aversion is the relevant way to introduce diminishing marginal *social* utility, and even argue that risk aversion has nothing to do with diminishing marginal utility and should not guide the degree of priority attributed to the worse off in the allocation of resources. These are controversial issues that are far from settled. A final issue is that the equivalent income approach can incorporate risk attitudes when considering risky situations, as done by [Fleurbaey and Gaulier \(2009\)](#) for the risk of unemployment. However, in [Fleurbaey and Zuber \(2025\)](#), it is argued that VNM utility measurement is a prominent contender for the measurement of individual well-being when constructing social welfare functions under risk, if one wants to respect the population risk attitudes especially in front of macroeconomic risks.

7.3 Matching alternative indicators and schools of thought

In conclusion of this section, it is worth comparing the list of approaches reviewed in this section to the schools of thought that conceive of specific ways to assess the state of a society on the basis of philosophical principles. Four main schools deserve to be listed, in view of the state of academic and political debates, as well as empirical surveys of opinions about social justice ([Almås et al., 2025](#)).

First, the utilitarian approach, a classical inspiration for economics and a significant school notably in the Anglo-Saxon world, is most explicitly invoked by prominent authors (e.g., [Layard and De Neve \(2023\)](#)) advocating the use of self-reported subjective well-being data, either of the evaluative or the hedonic sort. This is a perfect match between philosophy and statistics.

Second, egalitarianism and prioritarianism are schools of thought that assign greater priority to the worse off (and thereby seek to reduce inequality), but there are a diversity of ways to assess how well off individuals are. The extended preferences approach as well as our approach are most directly inspired by these schools of thought, as can be seen in our inequality and poverty adjustment terms. The theory of fair allocation has been the bridge between egalitarian theories of justice and welfare economics.³² Counting approaches can also potentially be related to these schools because one can notice that the capping of well-off people in the Alkire-Kovesdi approach described above implies that priority is given to improving the lot of the people who are worse-off than them.

A variant of egalitarianism, often called meritocratic (or responsibility-sensitive), claims that opportunities for well-being should be the relevant individual metric instead of well-being itself. The capabilities approach can also be enlisted into this category here. Since income, education and health, for instance, are key factors of individual opportu-

³¹Self-reported subjective scores, on the contrary, will fail this test when individuals have identical preferences but different scaling practices.

³²This bridge is particularly visible in classical texts such as [Kolm \(1976\)](#), [Varian \(1975\)](#) and more recently, [Fleurbaey and Maniquet \(2011\)](#), [Fleurbaey and Blanchet \(2013\)](#)

nities in life, one can say that all the approaches reviewed here do capture opportunities to some extent, and this language is often used to associate the HDI to the capabilities approach developed by Amartya Sen and Martha Nussbaum (see, e.g., [Nussbaum \(2002\)](#), [Sen \(2008\)](#)). However, this is only a loose relation, and there is an important literature in economics that has developed more explicit measures of opportunities, that involve partitioning the population into groups sharing the same initial circumstances and then looking at their prospects, usually assessed by their average performance.³³ However, this literature has focused on measuring opportunities to income, education, or health, but not yet on a comprehensive notion of well-being. A sensitive issue for such an approach is that it assigns variations among individuals to their personal responsibility, and this is bound to be controversial, since data on individuals' circumstances are scarce. In the empirical literature on opportunities, the typical circumstance variables are parental income, parental education, birth place, ethnicity. This list ignores many key factors of individual flourishing for which it would be preposterous to let individuals be considered liable. One can argue that this opportunity literature is useful to capture some sources of inequalities that are particularly amenable to policy corrections, but is not mature to measure the “true” opportunities that individuals face in life, and therefore not mature enough to offer promising alternative indicators of social progress.

Finally, an important school of thought in the public sphere is libertarianism, which advocates respecting the market mechanism and giving priority to the expression of free choice by individuals and the full exercise of property rights. This school has a tradition of questioning the project of measuring the state of society and seeking to maximize a social objective at the collective level, and a prominent advocate of this view was [Hayek \(1978\)](#). Therefore, it is not surprising that not much effort for building alternative indicators to GDP has been spent by libertarian economists.³⁴

8 Concluding remarks

This paper proposes a framework for the construction of headline indicators of current wellbeing. These indicators aim at striking a good balance between two desirable goals. First, they should meet the data constraints and the communication constraints faced by practitioners. This is a necessary condition for them to be adopted beyond academic circles. Second, they should be conceptually-grounded in a preference-based social welfare function. This is a necessary condition for making wellbeing comparisons that people would not deem implausible.

The framework proposes a generic formula that adjusts GDP per capita with a number of multiplicative factors. This modular definition allows the framework to remain agnostic on the relevant aspects of wellbeing that require adjustments. The paper traces the assumptions relating this framework to an underlying social welfare function. This connection provides the mathematical expression for the adjustment factors as well as a meaning to their weights, thereby providing guidance for the selection of their values. The paper considers five main types of adjustments. Among them, we have provided a foundation for the use of poverty and deprivation corrections on top of an inequality correction. We provide an empirical illustration of the framework, which showcases how

³³For surveys of this literature, see, e.g., [Peragine et al. \(2015\)](#), [Roemer and Trannoy \(2016\)](#).

³⁴See, however, [Fleurbaey and Maniquet \(2011\)](#) for an attempt at incorporating libertarian ideas into a social welfare function.

easy it can be to analyze and communicate wellbeing comparisons based on our headline indicators.

This paper leaves many questions open. We see it as the starting point for a research agenda. We conclude by listing a few questions left to future research.

First, the theory should be further developed. There is room for improving the inequality adjustment factor. In particular, one would like a simple expression relating inequality in equivalent incomes to dimension-specific inequalities, as well as the correlation between low achievements in different dimensions. The poverty adjustment factor should also be further developed. We have proposed one plausible and easy to communicate way of decomposing equivalent income poverty into monetary poverty and non-monetary deprivations. We have proposed one way to select a value for the related poverty aversion parameter. Our proposals need not be optimal. Also, one should investigate the conceptual relationships between the selection of the poverty line and deprivation cutoffs, on the one hand, and the weight given to their adjustment factors.

Second, our empirical application is restricted to monetary and mortality aspects. Many other potentially relevant non-monetary dimensions have been left out even though they admit largely accepted indicators and internationally comparable data, e.g., unemployment rates, hours worked, years of schooling, homicide per 100 000 person, etc. Their inclusion requires eliciting preferences to select a plausible value for their weight. We hope that the modularity of our BGDG indicator might encourage researchers to elicit values for their weight. Once a plausible value is found, it can directly be used for the integration of this dimension in all BGDG indicators that would deem this aspect relevant.

Third, one would like to quantify the bias introduced by our simplification assumptions. How costly are these assumptions in terms of wellbeing comparisons? How much do BGDG comparisons deviate from those made by their underlying social welfare function? How much closer are BGDG comparisons to SWF comparisons than are those of a composite headline indicator? It is possible to study these questions with rich datasets that are not faced with the data constraints requiring some of our simplifying assumptions. See for instance [Decerf et al. \(2025\)](#), which investigate the same kind of questions in the context of multidimensional poverty measurement.

References

- Adler, M. D. (2019). *Measuring social welfare: An introduction*. Oxford University Press.
- Adler, M. D. and Fleurbaey, M. (2016). *The Oxford handbook of well-being and public policy*. Oxford University Press.
- Adler, M. D. and Norheim, O. F. (2022). *Prioritarianism in practice*. Cambridge University Press.
- Alkire, S. and Kovesdi, F. (2020). A bird’s-eye view of well-being: Exploring a multidimensional measure for the united kingdom.
- Almås, I., Cappelen, A. W., Sørensen, E. Ø., and Tungodden, B. (2025). Fairness across the world. *NHH Dept. of Economics Discussion Paper*, (06).
- Atkinson, A. (1970). On the Measurement of Inequality. *Journal of Economic Theory*, 2:244–263.
- Benjamin, D. J., Cooper, K., Heffetz, O., Kimball, M. S., and Zhou, J. (2023). Adjusting for scale-use heterogeneity in self-reported well-being. Technical report, National Bureau of Economic Research.
- Boarini, R., Fleurbaey, M., Murin, F., and Schreyer, P. (2022). Well-being during the great recession: new evidence from a measure of multi-dimensional living standards with heterogeneous preferences. *The Scandinavian Journal of Economics*, 124(1):104–138.
- Brundtland, G. H. (1987). Our common future-call for action. *Environmental conservation*, 14(4):291–294.
- Da Costa, S., Fleurbaey, M., Decancq, K., and Schokkaert, E. (2026). Preference elicitation methods and equivalent income: An overview. *Reviews of Economic Literature*, 1.
- Decancq, K. and Lugo, M. A. (2013). Weights in multidimensional indices of wellbeing: An overview. *Econometric Reviews*, 32(1):7–34.
- Decancq, K. and Neumann, D. (2014). Does the choice of well-being measure matter empirically? an illustration with german data.
- Decerf, B. (2023). A preference-based theory unifying monetary and non-monetary poverty measurement. *Journal of Public Economics*, 222:104898.
- Decerf, B. (2025). On the properties of the two main types of global poverty lines. *Journal of Development Economics*, 173:103396.
- Decerf, B., Ferrando, M., and Menyhert, B. (2025). Multidimensional poverty: Why not make up the missing joint distribution data? Technical report, University of Namur, Development Finance and Public Policies.
- Dhillon, A. and Mertens, J.-F. (1999). Relative utilitarianism. *Econometrica*, 67(3):471–498.

- Dworkin, R. (2002). *Sovereign virtue: The theory and practice of equality*. Harvard university press.
- Fleurbaey, M. (2009). Beyond GDP: The Quest for a Measure of Social Welfare. *Journal of Economic Literature*, 47(4):1029–1075.
- Fleurbaey, M. and Blanchet, D. (2013). *Beyond GDP: Measuring welfare and assessing sustainability*. Oxford University Press.
- Fleurbaey, M. and Gaulier, G. (2009). International comparisons of living standards by equivalent incomes. *Scandinavian Journal of Economics*, 111(3):597–624.
- Fleurbaey, M. and Maniquet, F. (2011). *A theory of fairness and social welfare*, volume 48. Cambridge University Press.
- Fleurbaey, M. and Zuber, S. (2021). Fair utilitarianism. *American Economic Journal: Microeconomics*, 13(2):370–401.
- Fleurbaey, M. and Zuber, S. (2025). Universal social welfare orderings and risk. *Journal of Economic Theory*, 226:106014.
- Graham, C. (2012). *Happiness around the world: The paradox of happy peasants and miserable millionaires*. Oxford University Press.
- Harsanyi, J. C. (1976). *Essays on ethics, social behaviour, and scientific explanation*, volume 12. Springer Science & Business Media.
- Hayek, F. (1978). *Law, Legislation and Liberty, Volume 2*. University of Chicago Press.
- Jolliffe, D. and Prydz, E. B. (2021). Societal poverty: A relative and relevant measure. *The World Bank Economic Review*, 35(1):180–206.
- Jones, C. I. and Klenow, P. J. (2016). Beyond gdp? welfare across countries and time. *American Economic Review*, 106(9):2426–2457.
- Klugman, J., Rodríguez, F., and Choi, H.-J. (2011). The hdi 2010: new controversies, old critiques. *The Journal of Economic Inequality*, 9(2):249–288.
- Kolm, S.-C. (1976). Unequal inequalities. I. *Journal of Economic Theory*, 12(3):416–442.
- Kraay, A., Decerf, B., Jolliffe, D., Lakner, C., Ozler, B., Sterck, O., and Yonzan, N. (2023). *A New Distribution Sensitive Index for Measuring Welfare, Poverty, and Inequality*. World Bank.
- Layard, R. and De Neve, J.-E. (2023). *Wellbeing*. Cambridge University Press.
- Luce and Raiffa (1957). *Games and Decisions, Introduction and Critical Survey*. Wiley.
- Murtin, F., Boarini, R., Cordoba, J. C., and Ripoll, M. (2017). Beyond gdp: Is there a law of one shadow price? *European Economic Review*, 100:390–411.
- Nussbaum, M. (2002). Capabilities and social justice. *International Studies Review*, 4(2):123–135.

- Peragine, V., Ferreira, F., et al. (2015). Individual responsibility and equality of opportunity. In *Handbook of Well Being and Public Policy*. Oxford University Press.
- Pirttilä, J. and Uusitalo, R. (2010). A 'leaky bucket' in the real world: estimating inequality aversion using survey data. *Economica*, 77(305):60–76.
- Prati, A. and Senik, C. (2026). Is it possible to raise national happiness? *Journal of Public Economics*, 257:105619.
- Ravallion, M. (2012). Mashup indices of development. *The World Bank Research Observer*, 27(1):1–32.
- Rawls, J. (1997). Social unity and primary goods. *Frontier Issues in economic thought*, 3:276–280.
- Roemer, J. E. and Trannoy, A. (2016). Equality of opportunity: Theory and measurement. *Journal of Economic Literature*, 54(4):1288–1332.
- Samuelson, P. A. and Swamy, S. (1974). Invariant economic index numbers and canonical duality: survey and synthesis. *The American Economic Review*, 64(4):566–593.
- Sen, A. (2008). The idea of justice. *Journal of human development*, 9(3):331–342.
- Stiglitz, J., Sen, A. K., and Fitoussi, J.-P. (2009a). The measurement of economic performance and social progress revisited: reflections and overview.
- Stiglitz, J. E., Sen, A., and Fitoussi, J.-P. (2009b). Report by the commission on the measurement of economic performance and social progress. Technical report, Commission on the Measurement of Economic Performance and Social Progress, Paris.
- Varian, H. R. (1975). Distributive justice, welfare economics, and the theory of fairness. *Philosophy & Public Affairs*, pages 223–247.
- Watkins, K. (2006). *Human Development Report 2006: Beyond Scarcity-Power, Poverty and the Global Water Crisis*. United Nations Development Programme (UNDP) and Oxford University Press, New York.

9 Appendix

9.1 Selecting values for weights from SWB regressions

Weights γ_j should capture which percent of their income people would on average be willing to give up for an additional unit of dimension j .

Selecting a value for γ_j requires eliciting preferences. There exist various methods for eliciting preferences. One of them is to regress subjective wellbeing on outcomes.

Consider a SWB equation obtained from a typical regression:

$$SWB_i = \kappa + \beta_y \times \frac{y_i^{1-\rho}}{1-\rho} + \sum_j \beta_j x_i^j \quad (37)$$

where SWB_i is the subjective wellbeing of individual i , y_i denotes her income, ρ is the curvature that governs the elasticity of intertemporal substitution, β_y is the regression coefficient for income and β_j is the regression coefficient for the outcome x_{ij} of individual i in dimension j .

From this equation one can derive the average marginal WTP for an additional unit in outcome j , namely:

$$\gamma_j = \frac{\beta_j}{\beta_y} \times \bar{y}^{\rho-1} \quad (38)$$

where $\bar{y}$ denotes mean income. When $\rho = 1$, we are back to our BGDG formula.

9.2 Empirical illustration: average non-monetary outcomes only

This empirical illustration uses the same data sources, the same set of 131 countries over the same 1990-2023 period as those considered in Section 6. The illustrative purposes are the same as those explained in Section 6 (in a nutshell, showcase how easy it is to analyze and communicate wellbeing comparisons based on BGDG). The only difference with Section 6 is that this appendix only considers one of the four adjustment factors considered in Section 6.

Definitions

The BGDG indicator considered in this appendix adjusts GDP for average non-monetary outcomes only. It does so for a unique non-monetary dimension, namely health. Health is captured through average lifespan as measured by life expectancy at birth (LE). The BGDG indicator considered is defined as

$$BGDP_{LE} = GDP \times \underbrace{e^{\gamma_{LE} \times (LE - LE^*)}}_{A_{LE}} \quad (39)$$

so that trend analysis over a period t to t' decomposes into two components as follows:

$$BGDP_{LE} \text{ growth} \approx \underbrace{\ln \left(\frac{GDP'}{GDP} \right)}_{\sim GDP \text{ growth}} + \underbrace{\gamma_{LE} \times (LE' - LE)}_{\text{change in } LE} \quad (40)$$

The weight given to life expectancy is $\gamma_{LE} = 0.05$, which assumes that people are willing to live with a 5 percent lower income to gain one additional year of life. This value is consistent with the results from [Murtin et al. \(2017\)](#). The reference value used for normalization is $LE^* = 73.7$ years, which correspond to the median values in our sample of countries in 2023.³⁵

Cross-country comparisons in 2023

Table 3 provides BGD-LE values for a diverse sample of populous countries in 2023, ordered by increasing GDP per capita. For each country the table shows the BGD-LE value, the adjustment factor and the underlying indicator, so that one can immediately understand why a country’s BGD-LE deviates from its GDP. The table also provides median values per country-income group.

Table 3: Cross-country comparisons in 2023 with BGD-LE.

Country	GDP (\$ per year)	BGD-LE (\$ per year)	LE (years)	A_{LE} (-)
Ethiopia	842	612	67	0.73
Pakistan	1610	1189	68	0.74
Nigeria	2281	871	54	0.38
Indonesia	4193	3686	71	0.88
South Africa	5757	3915	66	0.68
Brazil	9288	10331	76	1.11
Mexico	10259	10975	75	1.07
China	12484	15427	78	1.24
Japan	36953	61911	84	1.68
France	39319	62314	83	1.58
United States	65187	82312	78	1.26
Median value LIC	736	405	64	0.6
Median value LMIC	2166	1459	69	0.78
Median value UMIC	6449	6958	74	1.04
Median value HIC	34240	56395	82	1.49

Note: Monetary amounts are expressed in 2021 PPPs. Reference value is $LE^* = 73.7$ years. Median values are computed for each column separately, so the median value for BGD is not equal to the product of median values of its factors.

Results in Table 3 illustrate a couple of points. First, BGD-LE is more unequal across countries than GDP: richer countries tend to have a larger BGD-LE value than their GDP value, while the reverse holds in poorer countries. This follows from the correlation between GDP and life expectancy.

Second, adjusting for life expectancy leads to rank-reversals among countries. This is for instance the case between Pakistan and Nigeria.

Third, there are no rank-reversals between countries that have very different GDP values, because the adjustment factor is positively correlated with GDP and tends to take values between 0.5 and 1.5.

³⁵ $LE^* = 73.73$ is the unrounded reference value used in all calculations. For readability, the paper report it rounded to $LE^* = 73.7$.

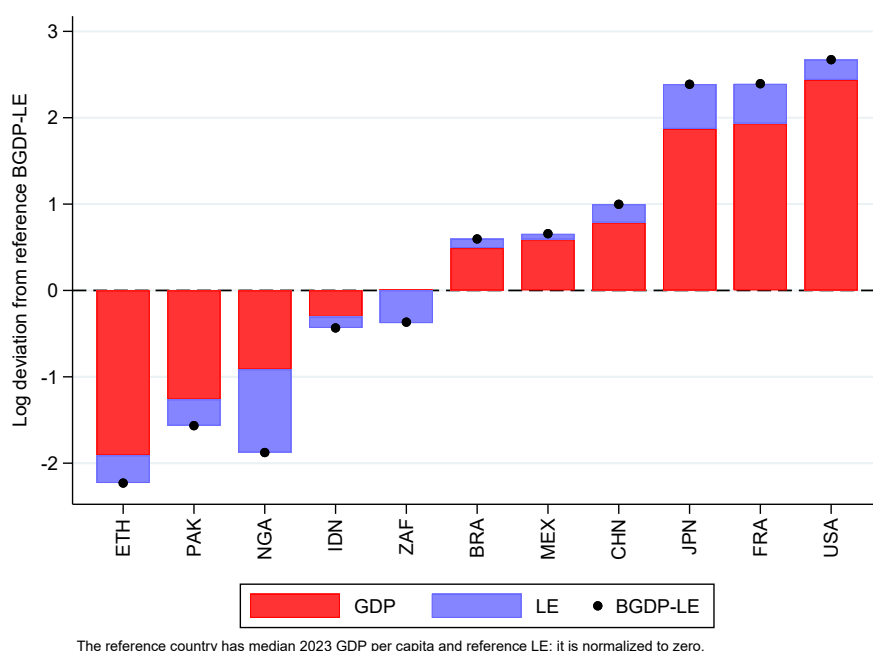
Decomposition of BGD level in 2023

Figure 7 investigates which of the two factors plays the main role in the value taken by BGD-LE, starting from a reference society in which both factors take their median value among the 131 countries in 2023, namely $GDP^* = 5688$ per person per year and $LE^* = 73.7$ years.

For instance, to reach the level of Brazil's BGD-LE both GDP and life expectancy should increase. Overall, BGD-LE in Brazil is about 60 log points above the reference society, of which GDP accounts for about 49 and life expectancy for about 11.

Figure 7 suggests one main finding: GDP plays the dominant role in BGD-LE levels, with life expectancy playing a smaller but far from negligible role.

Figure 7: Decomposition of BGD-LE level for selected countries



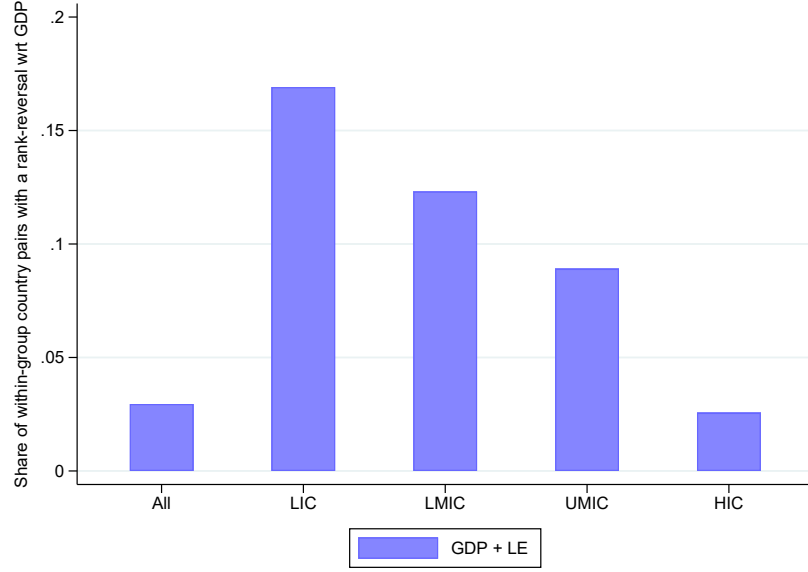
Notes: The figure decomposes the BGD change that would be necessary to move from the reference society to the level of BGD in each country. The reference society has all its factors to their reference levels, so that $BGD_{LE}^* = GDP^* \times 1 = GDP^*$ where GDP^* is the median value for GDP per capita in 2023. Reference values are $GDP^* = \$5688$ per person per year and $LE^* = 73.7$ years.

Rank-reversals in 2023 : quantification

Figure 8 shows, for different samples of countries, the probability that two countries drawn at random are ranked differently by BGD-LE and by GDP.

Rank-reversals are scarce when comparing countries with very different GDP levels: they amount to 3 percent of pairs in the full sample. The frequency declines monotonically with income: 17 percent within low-income countries, 12 percent within lower middle-income countries, 9 percent within upper middle-income countries and 2.5 percent within high-income countries. This reflects the greater dispersion of life expectancy at any given level of GDP among poorer countries.

Figure 8: Cross-country rank-reversals with respect to GDP in 2023



Notes: The figure shows the percentage of countries in each country-income category for which there is a rank-reversal between GDP and BGDP-LE.

Trends : the Covid-19 shock

Figure 9 shows the decomposition of the shock-related BGDP-LE change.

BGDP indicators allow for simple trend analysis. Take the decomposition of the BGDP-LE change in the US over 2019-2020 (left panel). The GDP terms contributes -2.6 log points and the life expectancy term -9, so that BGDP-LE falls by 11.6 log points. Roughly, this shows that GDP decreased by 2.6 percent while the life expectancy factor (A_{LE}) decreased by 9 percent, so BGDP-LE decreased by 11.6 percent. The decomposition shows that life expectancy accounts for roughly four fifths of the decline in BGDP-LE.

One can easily assess how the decomposition would change under a different weight γ_{LE} . The contribution of life expectancy is proportional to γ_{LE} , so a value of 0.075 instead of 0.05 would make the life expectancy bars 50 percent longer.

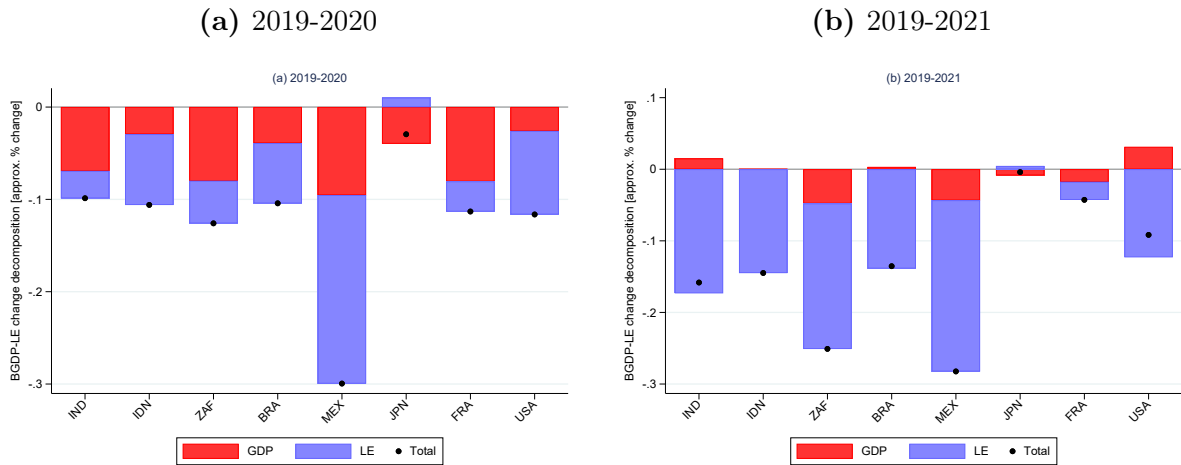
Figure 9 illustrates two main findings. First, as expected, in most countries the Covid shock reduces BGDP-LE, because life expectancy fell with the shock, as did GDP, at least in 2020. Second, countries had very heterogeneous experiences: the intensity of the shock on the different factors is heterogeneous, and even its direction can differ across countries. Contrast for instance Mexico and Japan. Mexico saw BGDP-LE fall by 30 log points, of which 20 came from life expectancy and 10 from GDP, while Japan fell by only 3 log points – and there the life expectancy term was positive, at +1, partly offsetting a GDP fall of 4.

Trends : progress over three decades, selected countries (1990-2023)

Figure 10 shows the progress over the last decades for a sample of populous countries.

We start with a word of caution. Because BGDP values have changed so much for most of these countries, we cannot interpret their value for BGDP change as the growth in their BGDP value. Log units no longer approximate percentage change well beyond

Figure 9: Impact of covid-shock on BGD-LE over 2019-2021

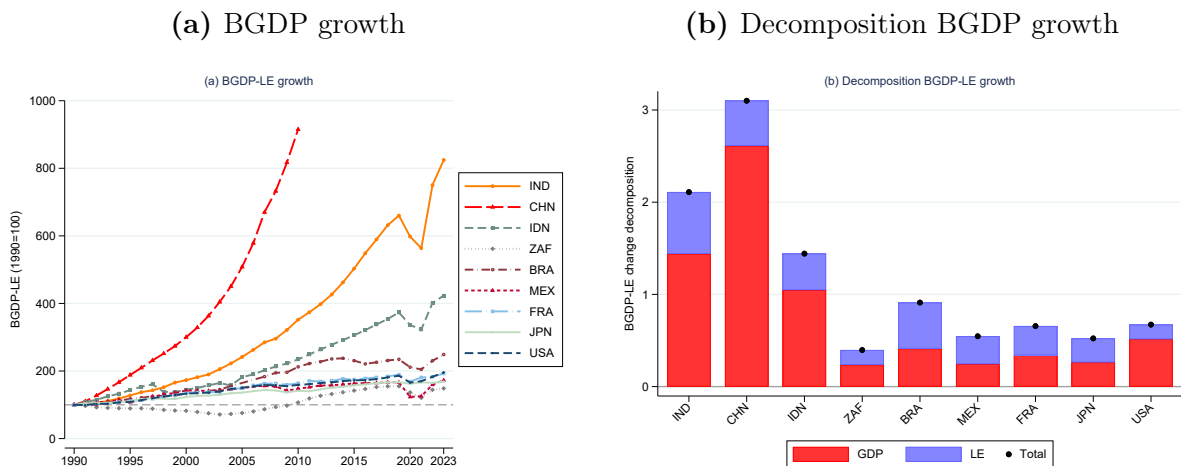


Notes: The figure shows the decomposition of BGD change across all BGD factors (log units).

0.2.

Three main findings are illustrated in Figure 10. First, the amount of progress is very heterogeneous across countries – BGD-LE rose about twenty-two-fold in China over 1990-2023 against 49 percent in South Africa – and progress tends to be larger for countries that were initially poorer, as illustrated by India, China and Indonesia. Second, BGD-LE captures more progress than GDP alone, mostly because there has also been significant progress in life expectancy. Third, the decomposition reveals which factor plays the larger role: in poorer countries that experienced high GDP growth, like India and China, that factor played the dominant role, while in richer countries like France improvements in life expectancy had an impact similar to GDP growth.

Figure 10: BGD-LE progress over 1990-2023 for select countries



Notes: The left panel shows BGD growth when normalizing BGD to its 1990 value. The right panel shows the decomposition of BGD change across BGD factors (log units).

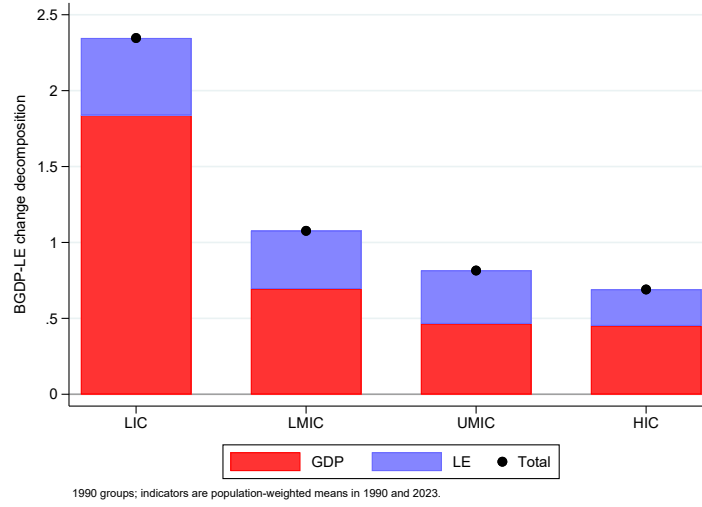
Trends : progress over three decades, country-income groups (1990-2023)

We conclude by examining how progress differs across country-income groups, fixing the composition of these groups to what it was in 1990. BGD is not subgroup decomposable,

so for each year we compute BGD_P at group level from the value of its factors at group level.

Two main findings emerge from Figure 11. First, BGD_P-LE captures more progress over 1990-2023 than GDP alone. Second, BGD_P-LE reveals more catching-up by poorer countries than GDP alone: differences have narrowed across country-income groups more than differences in GDP, because improvements in life expectancy have been larger in poorer groups. This is particularly striking when comparing upper middle-income and high-income countries, which have similar GDP growth but where the former show larger BGD_P growth.

Figure 11: Decomposition of BGD_P change between 1990-2023 by country-income groups



Notes: The figure shows the decomposition of BGD change across all BGD_P factors (log units). For the whole period, countries are classified across country-income groups based on their 1990 classification. For each country-income group and each year, the value of life expectancy is approximated by its population-weighted average value in the group.

9.3 Empirical illustration: average non-monetary outcomes and inequality

This empirical illustration uses the same data sources, the same set of 131 countries over the same 1990-2023 period as those considered in section 6 and 9.2. The only difference with Section 9.2 is that this appendix adds a second adjustment factor, capturing income inequality.

Definitions

The BGD_P indicator considered, which we call BGD_P-Basic, is defined as

The weight given to life expectancy is again $\gamma_{LE} = 0.05$. The normalization values are $Gini^* = 0.35$ and $LE^* = 73.7$ years, which correspond to the median values in our sample of countries in 2023, respectively for *Gini* and *LE*.

Cross-country comparisons in 2023

Table 4 provides BGDG-Basic values for a diverse sample of populous countries in 2023, ordered by GDP per capita.

Results in Table 4 illustrate a couple of points. First, BGDG-Basic is more unequal across countries than GDP: richer countries tend to have a larger BGDG-LE value than their GDP value, while the reverse holds in poorer countries. This follows from the correlation between GDP and life expectancy. In contrast, there is much less correlation between GDP and income inequality.

Second, adjusting for life expectancy leads to rank-reversals among countries. This is for instance the case between Pakistan and Nigeria or Indonesia and South Africa. The later rank-reversal finds its origin in the high income inequality in South Africa.

Again, there are no rank-reversals between countries that have very different GDP values. A country that performs well in non-GDP dimensions can hardly catch-up with another country whose GDP value is several times its own.

Table 4: Cross-country comparisons in 2023 with Basic BGDG.

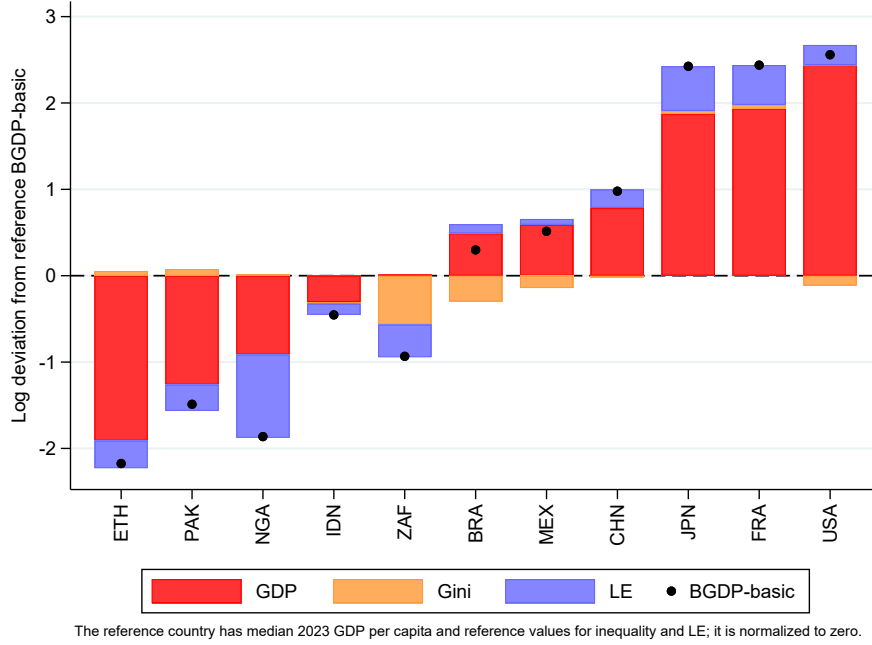
Country	GDP (\$ per year)	BGDG-Basic (\$ per year)	Gini (-)	A_{Gini} (-)	LE (years)	A_{LE} (-)
Ethiopia	842	646	0.31	1.06	67	0.73
Pakistan	1610	1284	0.30	1.08	68	0.74
Nigeria	2281	883	0.34	1.01	54	0.38
Indonesia	4193	3613	0.36	0.98	71	0.88
South Africa	5757	2236	0.63	0.57	66	0.68
Brazil	9288	7669	0.52	0.74	76	1.11
Mexico	10259	9511	0.44	0.87	75	1.07
China	12484	15143	0.36	0.98	78	1.24
Japan	36953	64285	0.32	1.04	84	1.68
France	39319	65181	0.32	1.05	83	1.58
United States	65187	73475	0.42	0.89	78	1.26
Median value LIC	736	382	0.37	0.96	64	0.6
Median value LMIC	2166	1412	0.38	0.95	69	0.78
Median value UMIC	6449	6998	0.36	0.98	74	1.04
Median value HIC	34240	56828	0.32	1.04	82	1.49

Note: Monetary amounts are expressed in 2021 PPPs. Reference values are $Gini^* = 0.35$ and $LE^* = 73.7$ years. Median values are computed for each column separately. This implies that median value for BGDG is not equal to the product of median values of its factors.

Decomposition of BGDG-Basic level in 2023

Next, Figure 12 investigates which of the three factors plays the main role in the value taken by BGDG-Basic. This figure takes advantage of the additive decomposability of BGDG-Basic growth. To decompose a country's BGDG-Basic level, the figure starts from the reference society, where all factors take their median value among the 131 countries in 2023, namely $GDP^* = \$5688$ per person per year, $Gini^* = 0.35$ and $LE^* = 73.7$ years. For such reference society, we have $BGDG_{Basic} = GDP^*$. The figure shows for each factor the change in log units necessary to get to the country's value.

Figure 12: Decomposition of BGDP-Basic level for selected countries



Notes: The figure decomposes the BGDP change that would be necessary to move from the reference society to the level of BGDP in each country. The reference society has all its factors to their reference levels, so that $BGDP_{Basic}^* = GDP^* \times 1 \times 1 = GDP^*$ where GDP^* is the median value for GDP per capita in 2023. Reference values are $GDP^* = \$5688$ per person per year, $Gini^* = 0.35$ and $LE^* = 73.7$ years.

Figure 12 suggests two main findings. First, GDP seems to play the main role in BGDP-Basic levels. Second, Figure 12 suggests that LE plays a smaller role, but often, though not always, larger than the role of $Gini$.

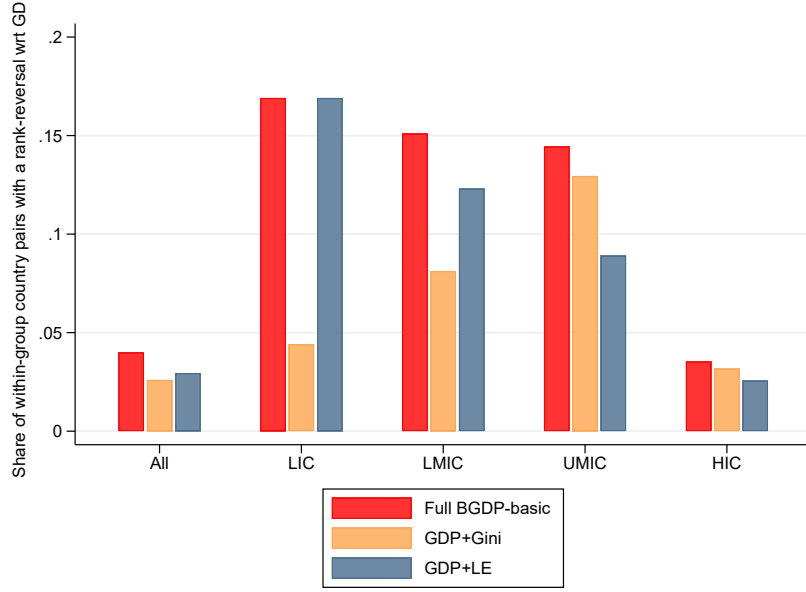
Rank-reversals in 2023 : quantification and main sources

We further explore rank-reversals in Figure 13. The figure shows, for different sample of countries, the probability that two countries drawn at random are ranked differently by GDP and BGDP-Basic. The figure also investigates which of the two adjustment factors plays a larger role in these rank-reversals. To do so, we take advantage of the modularity of BGDP. More specifically, we construct BGDP indicator based on a single adjustment factor. We then compute again the probability that two countries drawn at random are ranked differently by GDP and the resulting indicator.

Figure 13 illustrates two main points. First, rank-reversals between GDP and BGDP-Basic are scarce when comparing countries with very different GDP levels. Indeed, there are about 4 percent rank-reversals in the full sample (and among HICs). Rank-reversals mostly occur between countries within each of the four World Bank country-income group: low-income countries (LICs), lower middle-income countries (LMICs), upper middle-income countries (UMICs) and high-income countries (HICs). The percentage of rank-reversals increases around 15 percent among LICs, LMICs and UMICs.

Second, the adjustment factor that is most consequential in terms of rank-reversal depends on the level of GDP. Indeed, the figure shows that adjustment factor A_{LE} plays a larger role for rank-reversals among LICs and LMICs, while adjustment factor A_{Gini}

Figure 13: Cross-country rank-reversals with respect to GDP in 2023



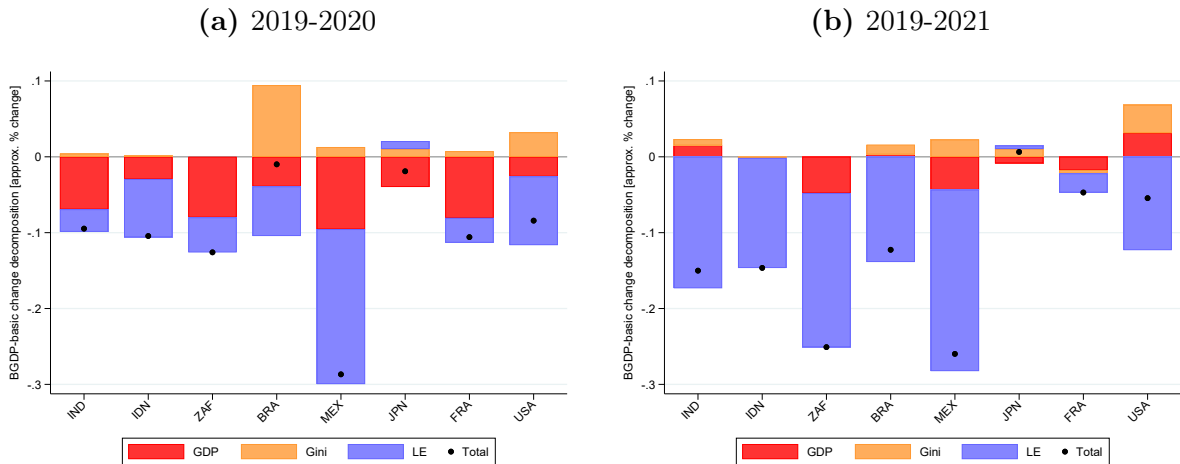
Notes: The figure shows the percentage of countries in each country-income category for which there is a rank-reversal between GDP and an alternative wellbeing indicator. GDP+Gini and GDP+LE are respectively defined as $GDP \times A_{Gini}$ and $GDP \times A_{LE}$.

plays a larger role for rank-reversals among UMICs.

Trends : the Covid-19 shock

The decomposition of the Covid-shock-related BGD-Basic change is shown in Figure 14.

Figure 14: Impact of covid-shock on BGD-Basic over 2019-2021



Notes: The figure shows the decomposition of BGD change across all BGD factors (log units).

BGD indicators allow for simple trend analysis. Take for instance the decomposition of BGD-Basic change in the US over the period 2019-2020 (left panel). The main change is that the life expectancy adjustment factor is reduced by about 9 percent. GDP is also reduced by about 3 percent. In contrast, social protection measures enacted during the

pandemic have lead to a reduction in inequality. As a result, the adjustment factor for inequality improves by about 4 percent. Overall, BGD-Basic decreases by about 8 percent ($= -9 - 3 + 4$).

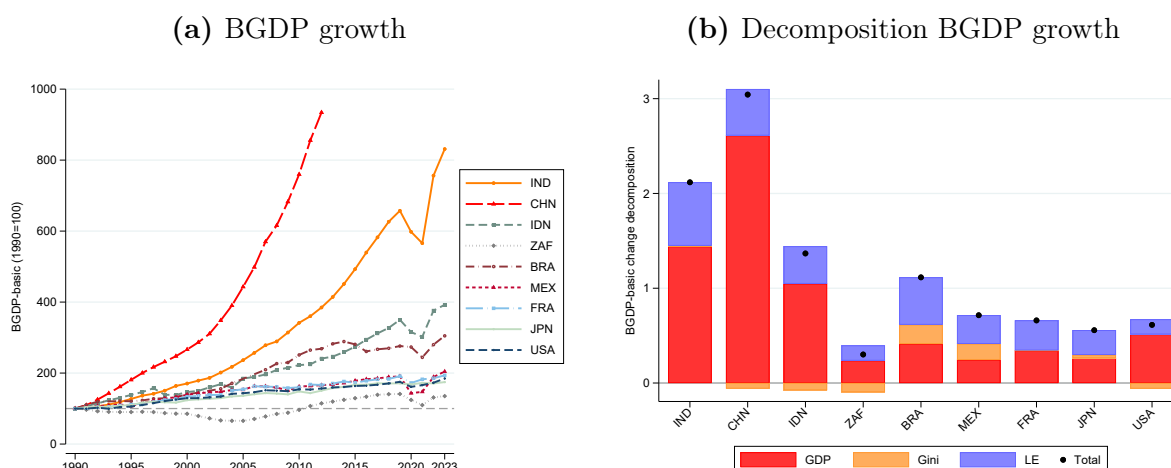
Figure 14 illustrate two main findings. First, as expected, in most countries, the covid-shock leads to a reduction in Basic BGD-Basic. The reason is that, in most countries, life expectancy has decreased with the shock (GDP as well, at least in 2020). In several countries like the US and Brazil, social programs enacted during the Covid-shock lead to a reduction in inequality, which mitigates the negative shock on BGD-Basic.

Second, countries had very heterogeneous experiences of the Covid-shock. The intensity of the shock on the different factors of BGD is heterogeneous. Even the direction of the shock can differ across countries.

Trends : progress over three decades, selected countries (1990-2023)

We start by analyzing progress over the last decades for a various sample of populous countries. Results are shown in Figure 15.

Figure 15: BGD-Basic progress over 1990-2023 for selected countries



Notes: The left panel shows BGD growth when normalizing BGD to its 1990 value. The right panel shows the decomposition of BGD change across all BGD factors (log units).

Three main findings are illustrated in Figure 15. First, the amount of progress is very heterogeneous across countries. Basic BGD increased more than twenty-fold in China, while it increased by about 33 percent in South Africa. The figure also suggests that progress tends to be larger for countries who were initially poorer, as illustrated by India, China and Indonesia.

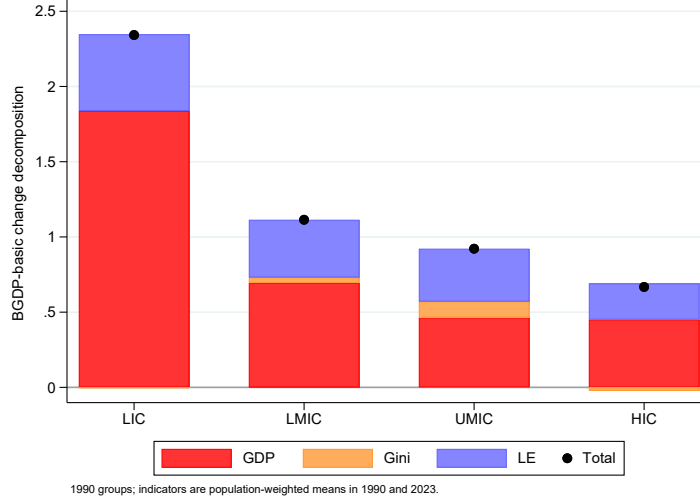
Second, BGD-Basic captures more progress than GDP alone. This is mostly due to the fact that there has also been significative progress in life expectancy.

Third, the additive decomposition of BGD change reveals which factor plays a larger role. In poorer countries that experienced high GDP growth, like India and China, this factor played the dominant role. In richer countries like France, improvements in life expectancy had a similar impact on BGD-Basic as GDP growth. In most countries, change in income inequality played a more modest role than changes in GDP and life expectancy. The inequality adjustment factor seems to play a larger role for cross-country comparisons than for trends.

Trends : progress over three decades, country-income groups (1990-2023)

We conclude the analysis of BGD-Basic by analyzing how progress differs across country-income groups. To do this, we fix the composition of these groups to what it was in 1990. The decomposition of BGD-Basic change between 1990-2023 by country-income group is shown in Figure 16.

Figure 16: Decomposition of BGD-Basic change between 1990-2023 by country-income groups



Notes: The figure shows the decomposition of BGD change across all BGD factors (log units). For the whole period, countries are classified across country-income groups based on their 1990 classification. For each country-income group and each year, the value of Gini and life expectancy is approximated by its population-weighted average value in the group.

Two main findings emerge from Figure 16. First, BGD-Basic captures more progress over 1990-2023 than GDP alone.

Second, BGD-Basic reveals more “catching-up” by poorer countries than GDP alone. More precisely, differences in BGD-Basic has been more reduced across country-income groups than differences in GDP. The reason is that improvements in life expectancy have been larger in poorer groups than in richer groups. This is particularly striking when comparing UMICs and HICs. These two groups have similar GDP growth, but UMICs have a larger BGD-Basic growth because of their larger progress in life expectancy and inequality.

9.4 Plausible values for the poverty aversion parameter α

In this section, we explore plausible values for the poverty aversion parameter α . This is done by considering a CES definition for the poverty penalty. This CES definition is based on a parameter ε for inequality aversion below the poverty line.

A CES definition for the poverty penalty

We consider in this section a particular expression for function u_{IP} . The idea is that u_{IP} corresponds to the CES function u_η above z , but below z function u_{IP} is characterized

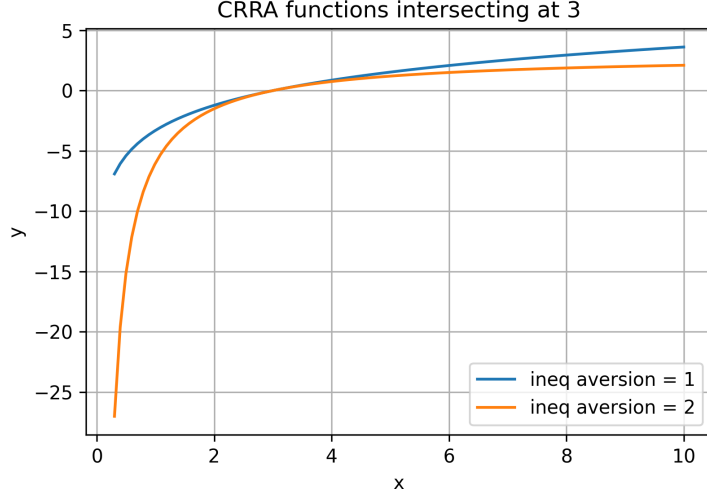


Figure 17: Example of function $u'_{\eta\varepsilon}$ whose regime changes in $z = 3$ ($\eta = 1$ and $\varepsilon = 2$). The graph for $u'_{\eta\varepsilon}$ corresponds to the orange (blue) curve below (above) z .

by another CES function u_ε characterized by a higher inequality aversion ($\varepsilon \geq \eta$). The resulting function $u_{\eta\varepsilon}$ is smooth when defined as³⁶

$$u_{\eta\varepsilon}(w_i, z) = \begin{cases} \frac{w_i^{1-\eta}}{1-\eta} & \text{if } w_i \geq z \\ \frac{z^\varepsilon}{z^\eta} \times \left(\frac{w_i^{1-\varepsilon} - z^{1-\varepsilon}}{1-\varepsilon} \right) + \frac{z^{1-\eta}}{1-\eta} & \text{if } w_i < z \end{cases} \quad (41)$$

which for $u_I = u_\eta$ implies a poverty penalty equal to

$$d_{\eta\varepsilon}(w_i, z) = z^{1-\eta} \times \left(\frac{\left(\frac{w_i}{z}\right)^{1-\eta} - 1}{1-\eta} - \frac{\left(\frac{w_i}{z}\right)^{1-\varepsilon} - 1}{1-\varepsilon} \right) \quad \text{if } w_i < z \quad (42)$$

which defines a poverty measure $P_{\eta\varepsilon}$ that is sensitive to inequality among the poor when $\varepsilon > \eta$. Figure 17 provides an illustration with $\eta = 1$, $\varepsilon = 2$ (for $u'_{\eta\varepsilon}$ defined in footnote 36).

One benefit of Eq.(42) is that the poverty penalty $d_{\eta\varepsilon}$ only depends on two normative parameters, namely η and ε . These parameters capture aversion to inequality, respectively above and below the poverty line. There is a literature that investigates which values of inequality aversion correspond to people's views on this parameter (Pirttilä and Uusitalo, 2010). This literature can thus provide guidance about plausible values for these parameters.

³⁶ The mathematical expression for $u_{\eta\varepsilon}$ below z is a linear transformation of $\frac{w_i^{1-\varepsilon}}{1-\varepsilon}$, whose purpose is to ensure $u_{\eta\varepsilon}$ remains smooth at z . An alternative definition for $u_{\eta\varepsilon}$ that would yield the same poverty penalty $d_{\eta\varepsilon}$ is

$$u'_{\eta\varepsilon}(w_i, z) = \begin{cases} z^\eta \times \frac{w_i^{1-\eta} - z^{1-\eta}}{1-\eta} & \text{if } w_i \geq z \\ z^\varepsilon \times \frac{w_i^{1-\varepsilon} - z^{1-\varepsilon}}{1-\varepsilon} & \text{if } w_i < z \end{cases}$$

Function $u'_{\eta\varepsilon}$ more clearly reveals that each of the two parts is exclusively based on one of the parameters η and ε . In turn, function $u_{\eta\varepsilon}$ boils down to u_η in case $\varepsilon = \eta$, preserving a clearer link with Atkinson's inequality indices.

One limitation of Eq.(42) is that the poverty penalty $d_{\eta\varepsilon}$ is growing exponentially with the income gap to the poverty line and tends to infinity as income approaches zero. This yields an extreme sensitivity to measurement errors. This extreme sensitivity could make it unwise to use in practice a poverty measure defined by the penalty given in Eq.(42). We next propose an alternative definition for the poverty penalty that avoids this extreme sensitivity limitation. Yet, we calibrate (in Section 9.4) the weight of this alternative penalty in a way that takes advantage of the benefit associated to inequality aversion parameters.

Relating parameter α to inequality aversion ε

We suggest that the calibration for parameter α be guided by a utility function u_{IP} defined by two different inequality aversion regimes, as is the case for $u_{\eta\varepsilon}$. By doing so, we can relate the value for α to plausible values for η and ε , whose values have been estimated in the literature.

Our above assumptions require that $\eta = 1$. For $\eta = 1$, where the underlying utility function is logarithmic, we can define the poverty penalty as the difference between the logarithmic function $\ln(w)$ and another function $u_\varepsilon(w, z)$ such that

- u_ε is based on inequality aversion ε ,
- u_ε is tangent to the logarithm at the poverty line, i.e., $u_\varepsilon(z, z) = \ln(z)$ and $\frac{\partial u_\varepsilon}{\partial w}|_{w=z} = \frac{\partial \ln}{\partial w}|_{w=z}$.

These two conditions on u_ε yield

$$u_\varepsilon(w, z) = \frac{1}{\varepsilon - 1} + \ln(z) - \frac{w^{1-\varepsilon}}{(\varepsilon - 1) \times (z)^{1-\varepsilon}} \quad (43)$$

Letting $d_{1\varepsilon}(w, z) = \ln(w) - u_\varepsilon(w, z)$, we define the poverty measure $P_\varepsilon(w, z) = \frac{1}{N} \sum_{i=1}^N d_{1\varepsilon}(w_i, z)^+$. The desired relationship between α and ε is obtained by requiring that

$$\frac{1}{N} \sum_{i=1}^N d_{1\varepsilon}(w_i, z)^+ = \frac{1}{N} \sum_{i=1}^N d'(y_i, x_i, z_y, (z_j)_{j \in J}) \quad (44)$$

which thus equalizes $P_\varepsilon(w, z)$, which depends on ε , with $P(y_i, x_i, z_y, (z_j)_{j \in J})$, which depends on α . In other words, Eq. (44) selects a value for α that yields the same poverty adjustment as the one that would be required when ε characterizes the regime of inequality aversion below the poverty line.³⁷

We make a comment on the interpretation to give to α . Eq. (44) relates α to ε . Parameter ε has two interpretations. First, ε captures inequality aversion among the poor. Second, the fact that the inequality aversion regime changes from η to ε when someone becomes poor also changes the priority given to the poor relative to the non-poor. Parameter α does not inherit the first interpretation. Indeed, α multiplies the PGR , which is insensitive to inequality among the poor. Therefore, α only captures the additional priority that a poor individual receives relative to a non-poor individual (on top of the inequality aversion $\eta = 1$ that applies to both poor and non-poor).

³⁷Recall that a reason for using $P(y_i, x_i, z_y, (z_j)_{j \in J})$ rather than $P_\varepsilon(w, z)$ is that the latter is extremely sensitive to low achievements and more difficult to communicate than the former.

The value for α implied in Eq. (44) depends on the distribution of outcomes considered. As we impose a common value for α for all countries, we need to select a benchmark value for α based on a benchmark distribution of outcomes. We consider two possibilities. First, we assume that all poor individuals have the same level of equivalent income equal to w_θ , which is for instance obtained when achievements in all dimensions are a fraction $\theta \in [0, 1]$ of the deprivation cutoff z_j . In that case, Eq. (44) boils down to

$$d_{1\varepsilon}(w_\theta, z)^+ = d'(\theta z_y, \theta(z_j)_{j \in J}, z_y, (z_j)_{j \in J}) \quad (45)$$

Second, we compute empirically the value α implied by Eq. (44) for a series of countries and keep the median value obtained for α . Each of these two possibilities comes with caveats, which we mention when detailing them below.

First, we consider theoretical values derived from Eq. (45). We develop its LHS using Eq. (43) and its RHS using Eq. (31), which yields

$$\ln(w_\theta) - \ln(z) - \frac{1}{\varepsilon - 1} + \frac{w_\theta^{1-\varepsilon}}{(\varepsilon - 1) \times z^{1-\varepsilon}} = \alpha \times \left((\ln(z_y) - \ln(\theta z_y)) + \sum_{j \in J} \gamma_j \times (z_j - \theta z_j) \right) \quad (46)$$

which simplifies to

$$\ln\left(\frac{w_\theta}{z}\right) - \frac{1}{\varepsilon - 1} \times \left(1 - \left(\frac{w_\theta}{z}\right)^{1-\varepsilon}\right) = \alpha \times \left(-\ln(\theta) + (1 - \theta) \times \sum_{j \in J} \gamma_j \times z_j\right). \quad (47)$$

From Eq. (28) and (29) we obtain that $\ln\left(\frac{w_\theta}{z}\right) = \ln(\theta) - (1 - \theta) \times \sum_{j \in J} \gamma_j \times z_j$, which we substitute into the RHS of Eq. (47) to get

$$\alpha = -1 + \frac{\frac{1}{\varepsilon - 1} \times \left(1 - \left(\frac{w_\theta}{z}\right)^{1-\varepsilon}\right)}{\ln\left(\frac{w_\theta}{z}\right)}. \quad (48)$$

Eq. (48) relates α to ε for particular values of the ratio $\frac{w_\theta}{z}$. This ratio captures the ratio that is typical for a poor person between her own equivalent income and the threshold equivalent income defining poverty. In Table 5, we expect this ratio to take values around 0.5 or 0.66.

Second, we consider empirical values for α implied by Eq. (44). There is one difficulty here, namely that $P_\varepsilon(w, z)$ cannot be computed in practice as we do not fully observe the joint distribution across all dimensions. To overcome this difficulty, we limit ourselves to the monetary dimension. That is, we compute for all countries the value of α for which

$$\frac{1}{N} \sum_{i: y_i < z_y} \left(\ln\left(\frac{y_i}{z_y}\right) - \frac{1}{\varepsilon - 1} \times \left(1 - \left(\frac{y_i}{z_y}\right)^{1-\varepsilon}\right) \right) = \alpha \times PGR(y, z_y) \quad (49)$$

and report the median value.

Table 5 summarizes the values for α obtained using these two methods.

We make a few comments on these values.

First, these values differ substantially, showing that different weights could plausibly be given to the poverty adjustment.

Table 5: Benchmark values for parameter α .

	Equal poor outcomes Eq. (48)		Empirical monetary Eq. (49) median 2023
	$w_\theta/z = 0.66$	$w_\theta/z = 0.5$	
$\varepsilon = 1$	0	0	0
$\varepsilon = 2$	0.24	0.44	0.76
$\varepsilon = 3$	0.56	1.16	2.58

Note: Inequality aversion for the inequality adjustment is assumed $\eta = 1$. The monetary poverty line used is the country-specific societal poverty line (Jolliffe and Prydz, 2021) for 170 countries in 2023.

Second, for a given value of ε , our estimates still differ substantially, but they do provide an order of magnitude that helpfully constrains the value for α . Indeed, the empirical method yields an estimate three times larger than the (smallest of the) theoretical method when $\varepsilon = 2$, respectively five times when $\varepsilon = 3$. Hence, for a given value of inequality aversion, the value for weight α is (loosely) constrained.

Third, the theoretical estimates should be understood as lower bounds. The reason is that they are based on the assumption that all poor individual have the same equivalent income. In practice, these values differ across poor individuals and the poverty penalty increases exponentially as a function of the distance to the poverty threshold. As a result, the penalty of the average poor individual underestimates the average penalty among the poor.³⁸ Our theoretical estimates for α should thus be best interpreted as lower bounds. For this reason, we consider our empirical estimates to be more reliable estimates. In our empirical application, we select as benchmark value $\alpha = 1.5$, which is a middle of the road value between the empirical estimates for $\varepsilon = 2$ and $\varepsilon = 3$.

9.5 Empirics: construction of our sample of countries

We restrict the sample of countries so that results for BGD_P (with four adjustment factors) can be computed for all countries.

In particular, we reject all countries for which:

- there are fewer than two observations for life expectancy over the period 1990-2023,
- there are fewer than two observations for Gini over the period 1990-2023, or there are no observation during either of the windows 2000-2010 and 2010-2020,
- one adjustment factor cannot be computed in 1990 or 2023, after interpolation / extrapolation.

Here is the list of countries that are excluded from our sample and have more than 30 million people: Tanzania, Myanmar, Uganda, Algeria, Argentina, Afghanistan, Yemen, Uzbekistan, Saudi Arabia.

Here is how we interpolate / extrapolate across years to get inequality results in the two line-up years 1990 and 2023. If we have observations before and after a line-up year, then we use a linear interpolation between the two closest dates for which we have observations. If we only have observations after 1990, then we impute in 1990 the value

³⁸We believe that values for the ratio $\frac{w_\theta}{z}$ equal to 0.5 or 0.66 correspond to plausible estimates for the average value of this ratio among individuals for whom $w_i < z$.

of the closest observation to 1990 (constant extrapolation). If we only have observations before 2023, then we impute in 2023 the value of the closest observation to 2023 (constant extrapolation).

For the Covid-shock analysis, we only consider countries for which all the data is available in each year of the 2019-2021 period.

Here are additional information related to the construction of BGDG results (Section 6): For the social poverty results, which require inequality data to compute the societal poverty line (which depends on median income), we use the same extrapolation / interpolation technique. For lifespan gap expectancy (LGE), we impute in 2023 the value from 2021, which was the latest year available at the moment these data were downloaded from GBD.

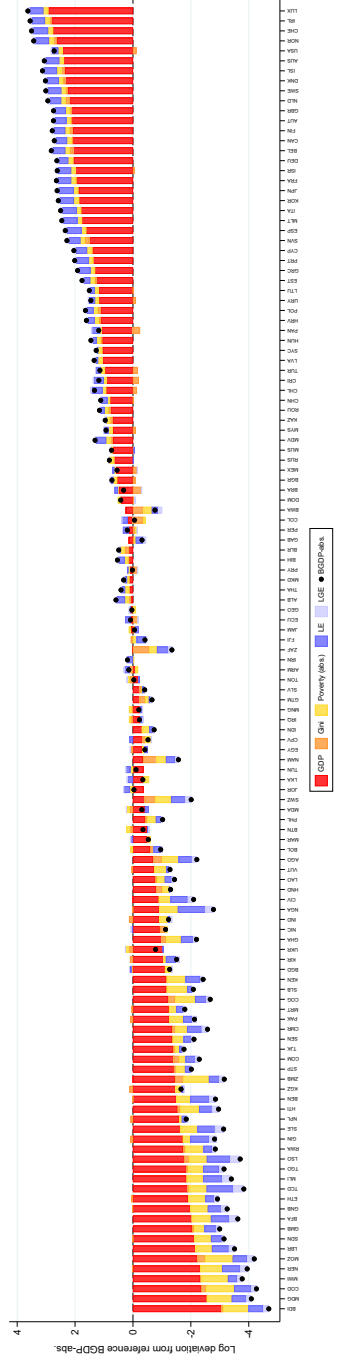
9.6 Additional empirical results for BGDG (Section 6)

Figure 18 confirms that GDP plays a dominant role in BGDG levels in 2023.

We then move to the alternative definition of the poverty line. We start by defining the country-specific poverty line considered. This definition is based on the Societal Poverty Line (SPL) proposed by Jolliffe and Prydz (2021). This weakly relative poverty line increases with median income in a way that approximates national poverty lines. For each country, the poverty line is thus the value of the SPL in 2023, which implies that richer countries have higher poverty lines. However, when evaluating progress over time within a given country, we anchor the poverty line to its 2023 value. That is, we keep the poverty line fixed to its real value in 2023. This ensures that a country's poverty standard does not change over time. We call "Societal poverty" the poverty adjustment computed from the SPL, denoted by A_{PGR}^{SPL} . We call BGDG SPL the value of $BGDG_{Pov}$ computed based on A_{PGR}^{SPL} . The reference value is $PGR_{SPL}^* = 0.06$, which corresponds to the median value in our sample in 2023.

Table 6 reports the results computed with the SPL. For comparison purposes, we report alongside the results computed from the absolute poverty line, using notation A_{PGR}^{Abs} and BGDG ABS.

Figure 18: Decomposition of BGDp level in 2023 for 131 countries (Abs poverty)



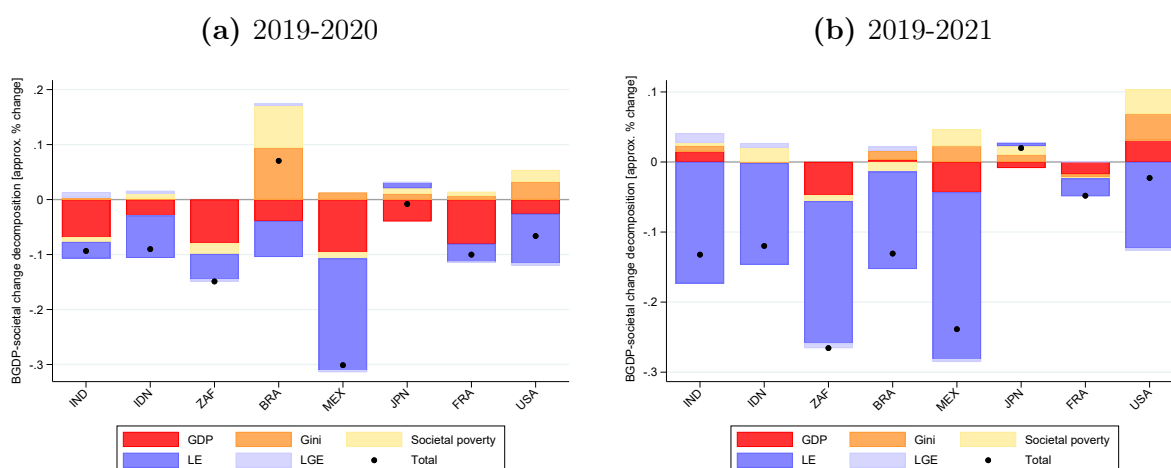
Notes: The figure decomposes the BGDp change that would be necessary to move from the reference society to the level of BGDp in each country. The reference society has all its factors to their reference levels, so that $BGDp^* = GDP^* \times 1 \times 1 \times 1 \times 1 = GDP^*$ where GDP^* is the median value for GDP per capita in 2023. Reference values are $GDP^* = \$5688$ per person per year, $Gini^* = 0.35$, $LE^* = 73.7$ years, $LGE^* = 0.96$ years and $PGR_{Abs}^* = 0.11$.

Table 6: Cross-country comparisons in 2023 with BGD (SPL and ABS).

Country	GDP (\$ a yr)	BGD Basic (\$ a yr)	BGD SPL (\$ a yr)	BGD Abs (\$ a yr)	Gini (-)	A_{Gini} (-)	LE (yrs)	A_{LE} (-)	PGR SPL (-)	A_{PGR}^{SPL} (-)	PGR Abs (-)	A_{PGR}^{Abs} (-)	LGE (yrs)	A_{LGE} (-)
Ethiopia	842	646	522	307	0.31	1.06	67	0.73	0.11	0.94	0.5	0.55	2.9	0.86
Pakistan	1610	1284	1109	679	0.30	1.08	68	0.74	0.05	1.01	0.42	0.62	3.1	0.85
Nigeria	2281	883	603	352	0.34	1.01	54	0.38	0.13	0.90	0.53	0.53	4.7	0.76
Indonesia	4193	3613	3518	2736	0.36	0.98	71	0.88	0.06	1.01	0.27	0.79	1.5	0.96
South Africa	5757	2236	1658	1484	0.63	0.57	66	0.68	0.17	0.86	0.28	0.77	2.9	0.87
Brazil	9288	7669	7184	7859	0.52	0.74	76	1.11	0.10	0.94	0.09	1.03	1.0	1.00
Mexico	10259	9511	9290	9872	0.44	0.87	75	1.07	0.07	0.99	0.07	1.05	1.2	0.98
China	12484	15143	16300	17326	0.36	0.98	78	1.24	0.04	1.04	0.04	1.11	0.5	1.03
Japan	36953	64285	68807	78229	0.32	1.04	84	1.68	0.05	1.01	0.01	1.15	0.2	1.06
France	39319	65181	71391	80195	0.32	1.05	83	1.58	0.03	1.04	0.00	1.17	0.3	1.05
United States	65187	73475	74530	86631	0.42	0.89	78	1.26	0.07	0.99	0.01	1.15	0.6	1.03
Median LIC	736	382	273	170	0.37	0.96	64	0.60	0.12	0.92	0.51	0.54	3.5	0.83
Median LMIC	2166	1412	1204	949	0.38	0.95	69	0.78	0.09	0.96	0.30	0.75	1.9	0.93
Median UMIC	6449	6998	7005	6722	0.36	0.98	74	1.04	0.06	1.00	0.06	1.07	0.9	1.01
Median HIC	34240	56828	63635	72218	0.32	1.04	82	1.49	0.04	1.03	0.01	1.16	0.3	1.05

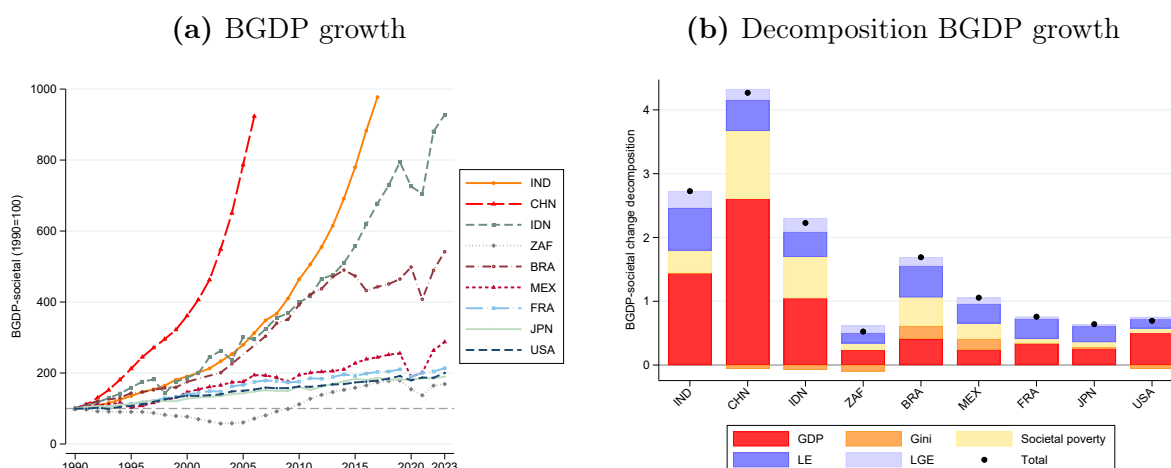
Note: Monetary amounts are expressed in 2021 PPPs. Reference values are $Gini^* = 0.35$, $LE^* = 73.7$ years, $LGE^* = 0.96$ years, $PGR_{Abs}^* = 0.11$ and $PGR_{SPL}^* = 0.06$. Median values are computed for each column separately. This implies that median value for BGD is not equal to the product of median values of its factors.

Figure 19: Impact of covid-shock on BGD extended over 2019-2021 (SPL poverty)



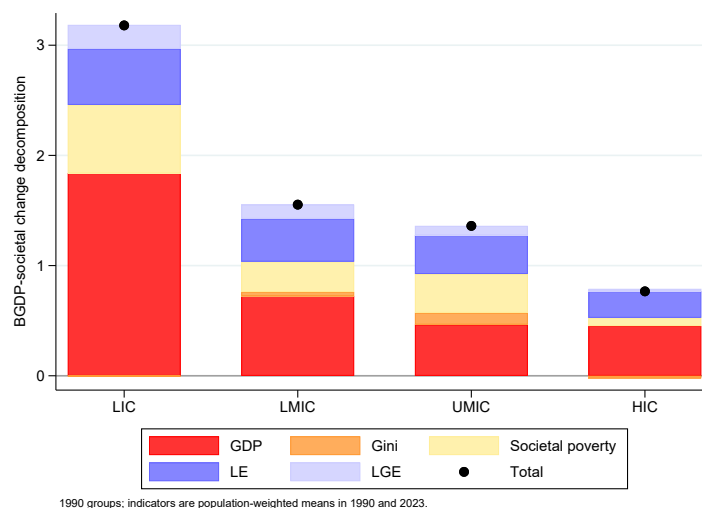
Notes: The figure shows the decomposition of BGD change across all BGD factors (log units).

Figure 20: BGD extended progress over 1990-2023 for select countries (SPL poverty)



Notes: The left panel shows BGD growth when normalizing BGD to its 1990 value. The right panel shows the decomposition of BGD change across all BGD factors (log units).

Figure 21: Decomposition of BGD change between 1990-2023 by country-income groups (SPL poverty)



Notes: The figure shows the decomposition of BGD change across all BGD factors (log units). For the whole period, countries are classified across country-income groups based on their 1990 classification. For each country-income group and each year, the value of Gini and life expectancy is approximated by its population-weighted average value in the group.