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# Experimenting with a strong dual necessity approach to social progress

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Different social progress indices assess well-being and development differently and thus reflect distinct conceptions of social progress. Broadly, these conceptions fall into two categories: ‘subjective’—the attitudes of individuals; and ‘objective’—external standards. Our starting point is a strong ‘dual necessity’ claim, namely that the two categories of conception have joint-special significance. Such a strong dual necessity conception, when operationalized, demands very low compensability/degree of substitution between the two independent indices, objective and subjective. Experimenting with this idea, we hypothesize that implementing low substitution empirically influences outcomes. Previous research presented this concept and exemplified initial empirical outcomes. The present work enhances and broadens this research by employing the constant elasticity of substitution (CES) function, which allows for the adjustment of substitution levels and comparison of resulting rankings. Furthermore, we demonstrate the results using two different well-known and commonly used indices: Human Development Index (HDI) and Sustainable Development Goals Index (SDGI). Our findings show that using a low substitution approach alters the social progress rankings of many countries in comparison to the original components’ rankings and to a high substitution combination of the two. This holds particularly true for countries in the middle of the original rankings. The paper’s original contribution is that it establishes the CES function as a useful device for implementing the idea of ‘dual necessity.’ Importantly, by experimenting with low substitution, and exemplifying its empirical significance with the CES function, the paper also contributes to further validating a strong dual necessity conception and justifies its own measurement. Such measurement should be of value to social scientists, practitioners and policymakers who care for balanced social progress: social progress that does not neglect either of the two aspects (subjective or objective).

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## Introduction

For decades, social scientists have pondered different conceptions and indicators of ‘social progress.’<sup>1</sup> This has occurred in the context of assessing comparative social progress. Two categories of conceptions have evolved: ‘subjective’ and ‘objective’; each category with its own theoretical justifications and conventional set of concepts and indicators.

‘Subjective’ conceptions point to the aggregate subjective attitudes, the ways by which individuals experience the social world, at the core of social progress; ‘objective’ conceptions point to specific non-attitudinal *external* features of the social world as the core of social progress (Michalos, 2017; Gasper, 2004, 2010; Berger-Schmitt and Noll, 2000). Subjective and objective conceptions emphasize two distinct aspects of social progress. In accordance, social scientists have developed various kinds of indicators to represent either one aspect, the other, or some combination (Fleurbaey and Blanchet, 2013; Brulé and Maggino, 2017; Berger-Schmitt and Noll, 2000; Diener and Suh, 1997; Anand and Sen, 1994; Costanza et al., 2008; Delhey and Steckermeier, 2016).

This paper experiments with the idea that social progress is the degree to which a society rigorously fulfills these two aspects together. With a conception of a strong ‘dual necessity’ in mind, a progressed society is defined as a society that performs highly in both aspects when one aspect cannot compensate for the other (see Cohen Kaminitz, 2024).

To adopt a strong dual necessity approach in representing social progress, we must express the two aspects as components in a functional form that permits only a low degree of substitution between them. This ensures a limited ability to compensate one aspect for the other. We call this the ‘low substitution approach.’ A low substitution approach on the indicators level represents a strong dual necessity on the conceptual level.

These conceptual and empirical approaches are different from those usually underpinning existing national and international indices, in which the common (implicit) assumption either favors one conception, subjective or objective, or assumes a substantial degree of substitution/compensation between components. For example, the well-established UN Human Development Index (HDI) lacks a subjective component, the World Happiness Ranking (WHR) rests solely on a subjective component, and the OECD Better Life Index (BLI) combines objective and subjective components with a substantial degree of substitution.<sup>2</sup>

Our research focuses on the hypothesis that adhering to a strong dual necessity conception, and hence to a very low level of substitution between objective and subjective components, matters empirically. We hypothesize that different degrees of substitution result in different rankings of social progress. In particular, a very low degree of substitution—which represents a strong version of dual necessity—results in significantly different rankings for a substantial number of societies/countries. Confirming this hypothesis, the research contributes to ‘discriminant validation’ (Adcock and Collier, 2001, 540), i.e., it strengthens the claim that a strong dual necessity is a distinct conception of social progress. At the same time, it supports the assertion that this concept deserves its own most valid measurement.

While a similar hypothesis was recently confirmed by Cohen Kaminitz (2024), our operationalization of this research hypothesis enhances and broadens these conclusions by employing the constant elasticity of substitution (CES) function, a common economic tool for comparing outcomes under different degrees of substitution. This allows us to compare social progress rankings under the low substitution approach relative to alternative degrees of substitution and to change the substitution level as we choose. Furthermore, we experiment with different indices and can show that the results presented in previous research are robust and hold for many cases.

Implementing a strong dual necessity with low substitution between two components (subjective and objective) is not just a technical exercise. It substantiates a significant interpretation of how we ought to understand social progress in the 21st century. It reflects the normative stance that both aspects of social progress—perceived welfare (welfare as experienced by individuals) and well-justified external objective standards—are necessary and only jointly required for social progress.

To the extent we accept this normative stance, we can functionally represent it with a CES function. The CES function works here like a pencil sharpener of existing indices—sharpening the validity of their measurements and allowing us to represent a strong dual-necessity conception.

This paper briefly discusses this interpretation from a normative perspective, primarily expanding on earlier analyses. Its key contribution lies in examining the empirical significance of this concept by employing various indices and the CES function, which subsequently serves as an effective tool in illustrating and implementing the idea.

## The Low-Substitution approach as an interpretation of ‘strong dual necessity’

Generally, indicators reflect specific conceptions (Cartwright and Runhardt, 2014), and various social progress indicators embody different conceptions of social progress (Fleurbaey and Blanchet, 2013; Gasper, 2004, 2010; Berger-Schmitt and Noll, 2000). Social scientists differentiate between the conceptual level and the indicators level. Therefore, while indicators are intended to represent conceptions, an initial conceptual analysis is necessary to clarify the precise role of indicators and the division of labor between them (Adcock and Collier, 2001; Goertz, 2006, 2020).

Conventionally, although not necessarily, subjective concepts (‘utilitarianism,’<sup>3</sup> for instance) are represented by subjective indicators, such as Life Satisfaction surveys, and objective concepts (‘needs,’ ‘capabilities,’ for instance) are represented by objective indicators, such as average income, longevity, years of schooling, etc.

The ‘strong dual necessity’ conception rests on previous conceptions of social progress but suggests a new way of addressing them *jointly*. The **subjective** conception has a longstanding philosophical tradition behind it. In recent decades, the (subjective) ‘welfarist’ and utilitarian traditions have gained significant prominence in supporting various streams of social progress research (Layard, 2005, 2010; Frijters et al., 2020). It represents the view that what ultimately matters for social progress is the aggregate subjective attitudes of the people in a given society. Attitudes may consist of actual feelings, such as pleasure, happiness, the satisfaction of desires and preferences, or judgments and beliefs that life as a whole is good/bad based on deeper reflections. Attitudes can be either emotive or cognitive, depending on the particular conception adopted (See Angner, 2009; Alexandrova, 2017, 2005; Fabian, 2022, chapters 1–3).

The **objective** (non-attitudinal/external) conceptions draw on distinguished traditions beyond subjective attitudes. ‘Basic needs’ (Gasper, 2007), ‘freedom’ and ‘capabilities’ (Sen, 1988; Alkire, 2016), ‘sustainability’ (Laurent, 2017), and ‘social cohesion’ (Chan et al., 2006; Delhey et al., 2018) exemplify conceptions in this category, conditioned by the question of whether they are taken to be significant to social progress *regardless* of their impact on subjective attitudes. Objective conceptions are regarded as either universal or local and may change between societies and times (McGregor, 2018).

The point of dual necessity is that these two philosophical conceptions can be justified together independently (Kagan, 2009

and Woodard, 2016) suggest this on the individual level; Cohen Kaminitz, 2020 adopts it on the social level). To operationalize a robust interpretation of this insight—transitioning it from the conceptual level to the indices level—each of the conceptions (subjective and objective) is transformed into components of a single, unified ‘basic-level concept’ (Goertz, 2006, 2020), when:

- Each component (‘subjective’ and ‘objective’) is necessary for indicating social progress.
- They are only jointly sufficient to indicate social progress (therefore, one can compensate for the other only to a very limited extent).
- These assertions are derived from a *normative* view which is independent of possible *empirical* causality and correlation between the two components.

In attempting to operationalize these premises and represent them through measurement, we follow the approach outlined in Cohen Kaminitz (2024) (section 4). This involves using a single index with two well-constructed components (each representing one of the distinct requirements) that are equally weighted. This method aligns with Goertz’s (2020, chapter 6) ideas, which emphasize that when two components of a basic concept are acknowledged, determining the degree of substitution between them is a critical decision that reflects their ‘logical structure’ and illustrates how they complement each other Table 1.

The structure we advocate here, following Goertz (2020) and Cohen Kaminitz (2024), is on the level of the components (not necessarily the same as the relation between the indicators *within* each component). It is based on the strong dual necessity presumptions above, and it is the logical structure of two necessary, albeit only jointly sufficient components (the AND structure in Goertz). See Fig. 1.

As explained by Goertz (2020, pp. 167–176), this AND logic can be represented by different functional forms, with the shared attribute of low compensability or low substitution between the components. Cohen Kaminitz (2024) uses the extreme pole, which is a minimum functional form that takes only the weakest score as an input (as in the weakest link of Goertz and Dixon, 2006). However, this earlier research encouraged further exploration across a broader spectrum, as the extreme pole represents complete non-substitution—an extreme stance where the higher component is disregarded. The advantage of the CES function used in this paper is its ability to encompass the entire range of substitution, including particularly low degrees of substitution.

The operationalization of low substitution requires an initial phase of constructing or selecting the conceptions and indicators for the two components separately. This preliminary phase is complex and may vary across different contexts, depending on changing criteria. Nonetheless, irrespective of the components’ construction phase, the justification for maintaining a lower degree of substitution between them becomes stronger if both components are considered necessary for presenting social progress and only jointly sufficient.

Two kinds of questions emerge. First, on what grounds should we accept or reject the strong dual necessity conception and hence, the low substitution approach? Second, does the low substitution approach make a difference when ranking societies’ social progress? We focus on the second issue but briefly refer to the first.

Previous research highlights a few points regarding the grounds on which the idea of a strong dual necessity should be considered. First, they explain its uniqueness. While resembling other ideas of ‘pluralism’ of values, “this approach, and only this approach, attempts to capture the normative conviction that a society is not significantly better off unless the two conditions have been met” (Cohen Kaminitz, 2020, p. 13). Being unique/distinctive, it may be embraced in particular contexts: contexts in which we are: “interested in ‘progress’ in the sense of being less regressed” because “it ‘catches’... societies by their weaknesses and does not allow the stronger aspect to compensate for the weaker” (Cohen Kaminitz, 2024).

A strong dual necessity conception is, hence, distinctive and potentially significant. It also further sharpens our understanding of social progress. Even if we accept a unique, uncompromised role for subjective attitudes, it forces us to revisit the central question: What exactly is significant for social progress *regardless* of subjective attitudes in the 21st century?

However, its distinctiveness and conceptual significance do not necessarily imply that a strong dual necessity results in different rankings of social progress (hence requiring its own measurement). This is why empirical exercises are required.

Turning to the empirical exercise, it is helpful to underline how strong dual necessity and low substitution are distinguished from other approaches and methods that acknowledge the importance of combining subjective and objective data in the context of social progress measurements. For clarity and convenience, we present the main approaches and the differences between them and ours in Table 2.

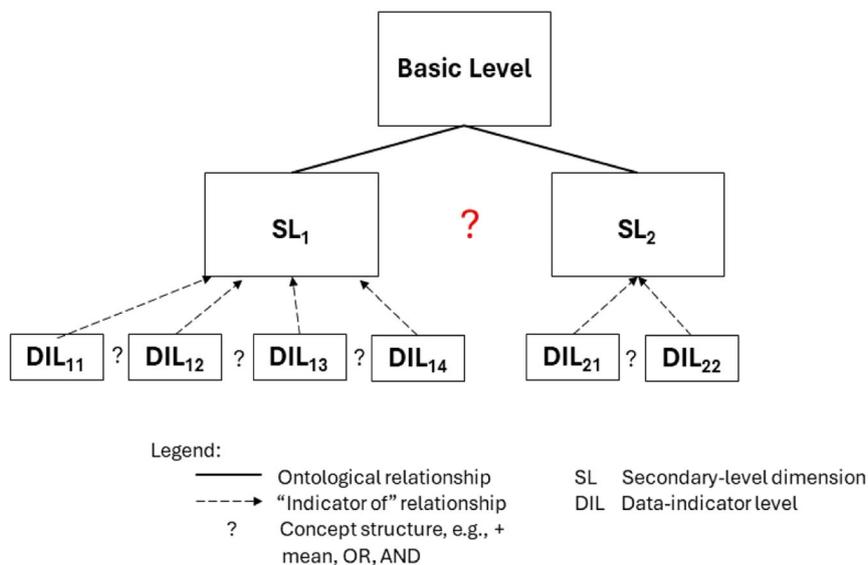
**Experimenting with the dual necessity conception and the low substitution approach**

**Selecting components.** In order to experiment with the low substitution approach, we need to select two indices as our two components. Choosing the components is not a trivial task and involves normative and scientific considerations. For the purpose of the current exercise, we select components based on ready-made, well-established, and highly used indices. They represent either objective or subjective conceptions (in our terminology). Other indices could be favored in other implementations of a strong dual necessity and low substitution approach.<sup>4</sup>

Various competing indicators have been developed to account for subjective attitudes, including Subjective Well-Being (SWB) indicators (Blanchflower and Bryson, 2024; Layard, 2010; Kahneman et al., 2004). One well-established example is used in the World Happiness Report (WHR), a life-ladder comparative indicator published by Gallup and based on a worldwide survey of people’s satisfaction with their life as a whole (Helliwell et al., 2020). According to our distinction, this indicator conceals a

**Table 1 The basic nomenclatures in use: ‘Weak/Strong dual necessity,’ OR/AND logical structure.**

	The ‘logical structure’: how the two components of a shared concept complement each other.	The functional representation of the logical structure in this research.
‘Weak dual necessity’	The OR structure (Goertz, 2020): The two components represent the concept and can compensate one for a lack in the other.	A CES function using a high degree of substitution.
‘Strong dual necessity’	The AND structure (Goertz, 2020): the two concepts represent a shared basic concept as necessary conditions when one cannot compensate for the other.	A CES function using a very low degree of substitution.



**Fig. 1 The three-level framework (taken from Goertz (2020, p. 28)).** The basic level here is the concept of Social Progress; SL1 is the subjective component; SL2 is the objective component (each of them is constructed by various DILs). With a strong Dual Necessity, the structure of the secondary level is the AND structure (the question mark in red).

**Table 2 Main alternative approaches when combining subjective and objective data.**

Approaches and methods	Main characteristics and outputs	The main difference from low substitution
<b>Searching for correlations and causality</b>	Empirical research focuses on recognizing correlations and causal mechanisms that connect subjective and objective data. Such inquiries often presuppose either subjective or objective conception (as in De Neve and Sachs, 2020; Frijters et al., 2020; Costanza et al., 2008; Inglehart et al., 2008; Delhey and Steckermeier, 2016).	Low substitution assumes a conception that combines both aspects, regardless of correlations and causal connections between them. The two approaches may complement each other by utilizing empirical causal relationships in order to improve the low substitution scores and rankings of societies. Importantly, with low substitution, we highlight the outlier societies—those that deviate from the average correlation (see Figs. 2, 5).
<b>Dashboards</b>	Acknowledging the necessity of multiple criteria, such solutions present the two types of information separately with different sets of scores and rankings. The assumption is that even though the two conceptions are regarded as necessary, the two sets of data are regarded as incomparable (Jean-Paul and Martine, 2018, p. 40; Ravallion, 2011, pp. 246–247).	Unlike the low substitution approach, this solution does not provide a unified scale. In some contexts, such a scale may be considered a useful and efficient comparative communication tool. The pitfall of a dashboard is that, in many cases, the user cannot come up with a conclusion, a bottom line, regarding the ‘basic-level concept’ (the level of ‘social progress’). The two approaches, nevertheless, share a requirement of not allowing one aspect to compensate for a lack of the other.
<b>Data-driven approaches</b>	These approaches assume that combining subjective and objective indicators should be based on data-driven (statistical) procedures, such as factor analysis, MIMIC multiple indicators and multiple causes, structural equation models (SEM), etc. (Alaimo et al., 2020; Brulé and Maggino, 2017; Krishnakumar and Nagar, 2008).	Low substitution assumes that the particular combination should be resolved by normative reasoning and not by data-driven procedures (for a discussion, see Decancq and Lugo, 2013; Goertz, 2020, pp. 57–66; Goertz and Mahoney, 2012). This is not necessarily to reject the use of data-driven techniques to construct each of the ‘objective’ and ‘subjective’ components (as in Krishnakumar and Ballon, 2008; Busseri et al., 2007; Busseri, 2018).
<b>Preference-based approaches</b>	These approaches advise eliciting individuals’ preferences regarding social progress aspects weights, either by equivalent income or stated preferences and other techniques (Decancq et al., 2015; Fleurbaey and Blanchet, 2013, chapter 4; Benjamin et al., 2014).	Unlike the low substitution approach, preference-based approaches refer to the subjective point of view not necessarily as an essential component per se but as the procedure through which weights are ascribed to components.
<b>High substitution</b>	A vast part of the existing social progress indices recognizes the two aspects and represent them together in one common functional form and score that implicitly assumes a high degree of substitution between them (Munda and Nardo, 2009; Ravallion, 2010; OECD, 2011, p. 26).	The low substitution approach adds to this approach the insight that, in some contexts, each of the two aspects is necessary and cannot be compensated by the other. This is reflected in a different functional form (the CES function would be a useful tool in making this adjustment).

subjective conception of social progress: it is supposed to represent social progress in the sense of (averaged) subjective attitudes. Hence, we select it to represent the subjective category.

Regarding the objective component, a variety of competing conceptions exist. We select two alternatives for such conceptions and indices. One is the UNDP Human Development Index (HDI), inspired by Amartya Sen's influential idea of *functionings and capabilities* as the core of social progress instead of 'utility' or 'subjective welfarism.' Functionings are 'the various doings and beings that people value and have reason to value'; capabilities are the 'real opportunities' that they have to accomplish these functionings (Sen, 1985; Alkire, 2016).

The Human Development Index is composed of three indicators, which together are held to represent the average capabilities of the individuals in a society (Anand and Sen, 1994). The three normalized indicators are income (log GDP in purchasing power parity), life expectancy in years, and education (a weighted average of literacy and school enrollment rates). In our terminology, the prestigious HDI is designed to represent an objective/external conception of social progress. We select it to represent this category.

Note how, although social scientists have explored correlations between the HDI index and subjective indicators (Hall, 2013; Kroll, 2015), its ultimate source of justification is *independent* of these correlations. It is not intended to represent subjective attitudes in the first place, but external circumstances, and therefore its validity does not depend on such a correlation.

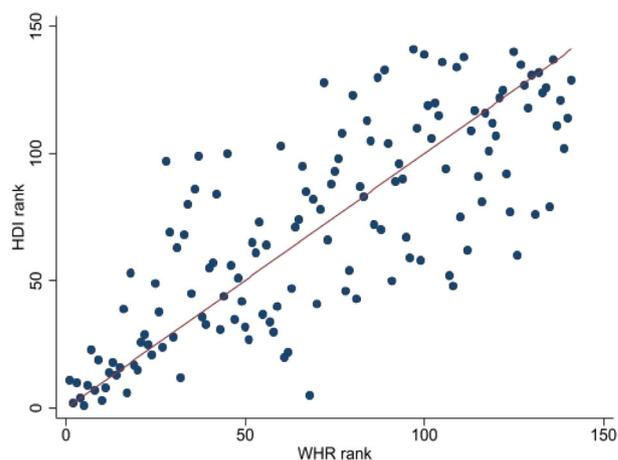
An alternative index we experiment with is based on the 17 Sustainable Development Goals (SDGs). Accepted by the international community as a part of the broader 2030 agenda, these are a comprehensive set of policy goals that aim to end world poverty and hunger, address climate change and environmental protection, and ensure universal access to healthcare, education, and equality. The SDG index, developed in 2015, is composed of 114 indicators that comprehensively represent these policy achievements (Sachs et al., 2019). Likewise, scholars have already explored *correlations* between the SDG index and subjective indicators (De Neve and Sachs, 2020).

Each of the two indices conveniently has accessible comparative scores. Each represents different objective standards (different conceptions), hence, providing an alternative potential component for our index of strong dual necessity and low substitution.

**Experimenting with Low Substitution scores and rankings—results.** In this sub-section, we empirically address the hypothesis that the low substitution approach matters—that a strong dual necessity is a distinctive conceptual approach, resulting in significantly different social progress rankings. Note how we focus here on whether it results in different rankings from its individual components and from a 'standard' high substitution between them.

We have to consider two issues when combining the two components: (1) the weights for each component, representing the relative importance ascribed to each conception, and (2) the level of substitution between them, representing the extent to which one can compensate for a lack of the other (Greco et al., 2019; Goertz, 2020). We focus here on the latter, less researched dilemma.

To operationalize the low elasticity of substitution, we use the constant elasticity of substitution function (CES). This function is widely employed in economics to represent both preferences and production functions. The main advantage of the CES function is its flexibility in substitution, allowing modeling scenarios where inputs can be substituted at varying rates—which is the main



**Fig. 2 The basic correlation between HDI and WHR 2019 rankings.** Rising dispersion below the rank of 25 in WHR. Rank correlations using Kendall tau (see appendix): all samples 0.59 and the quartile correlations based on WHR rank are: 1st 0.59; 2nd 0.05\*; 3rd 0.19\*; 4th 0.23. \* We can reject the null hypothesis of rank correlation at the 5% level.

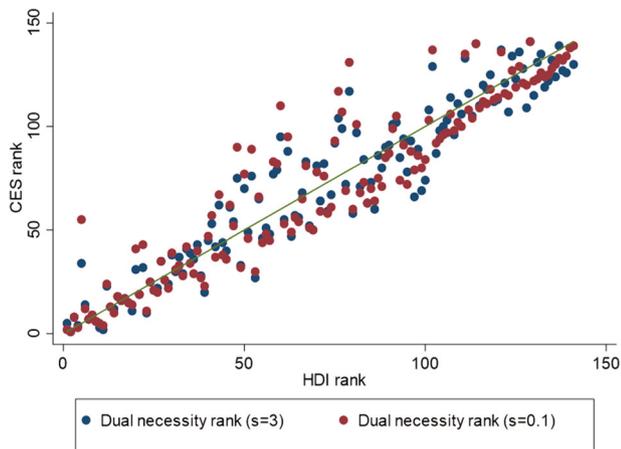
contribution of the dual necessity approach. It is a generalization of other functions that assumes either linearity or fixed degrees of substitution (see the appendix). It allows for parameterization of the elasticity of substitution, a feature we exploit below. Seemingly mathematically complex, it is, in practice, very tractable, and it is easy to interpret its empirical results. The CES function elasticity of substitution varies from 0 (no substitution at all) to infinity (perfect substitution). Perfect substitution is assumed in linear social progress indices.

To experiment with the significance of the low substitution approach for operationalization, we first take the World Happiness Ranking WHR and the Human Development Index HDI (2019) to represent the subjective and objective components, respectively. We use data from 141 countries with non-missing observations from the two sources. As we see in Fig. 2, the correlation between the two rankings is relatively low for the countries ranked in the second and third quartiles of the rankings of either index. The correlation between rankings drops to almost zero in the second quartile (see note, Fig. 2). Notwithstanding our normative stance about the desirability of the low substitution approach, this provides empirical support to employ our low substitution approach. Clearly, for a significant subset of countries, doing well in one conception is not strongly correlated with the other.

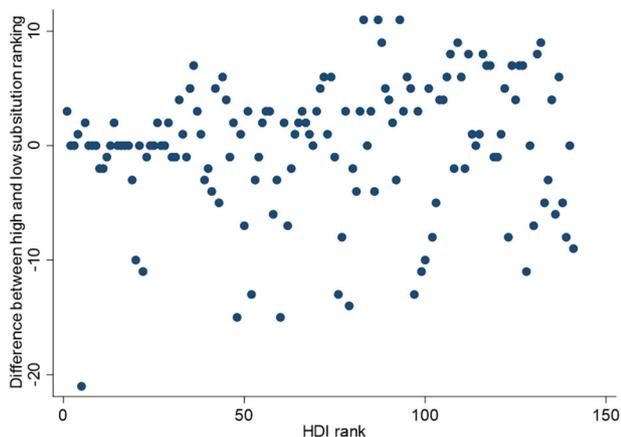
Because the HDI, WHR, and SDG scores are derived from different sources with different distributions and units, we compute a CES function by using the standardized (normalized with a mean of zero) values of these indices. We hypothesize, first, that when representing social progress, it would be empirically significant to use both indices and not only one of them; second, that different degrees of elasticities of substitution result in different ranks. We take, therefore, two elasticities to represent high and low elasticity of substitution between the indices  $\sigma = 3$  and  $\sigma = 0.1$ .

The choice of the exact elasticities is somewhat arbitrary. However, a very low elasticity of 0.1 is very close to 0—the case of no substitution or perfect complementarity. Conversely, an elasticity of substitution of 3 offers a high degree of substitution between subjective and objective measures in the social progress function. Our results carry through with higher degrees of substitutions.

We begin by illustrating the difference between using both the objective and subjective measures using the CES function with



**Fig. 3 Substitution between HDI and WHR (CES function) compared to HDI index ranking.** The countries are ranked according to two dual necessity CES functions, one with an elasticity of substitution of 3 (high) and one with an elasticity of substitution of 0.1 (low). They are then plotted against their rankings according to the Human Development Index (HDI).



**Fig. 4 Differences in country rankings according to CES function with high and low substitution by HDI ranking.** The quartile average differences between high and low substitution rankings (in absolute terms) are respectively: 1st 2.34; 2nd 3.97; 3rd 5.91; 4th 5.17. Quartiles based on HDI rank.

equal weights compared with using a single index such as the HDI. Figure 3 plots the ranking according to the CES function with two degrees of substitution, high and low, against the HDI ranking.

The deviations (the distance from the 45-degree line) are especially large in the middle-HDI group countries. In this range (40–100 HDI ranking), we find most of the outliers/anomaly countries. ‘Anomaly’ is defined here as an outlier case where the objective component score does not fit our expectations according to the subjective component score, and vice versa (our expectations build on the general correlation). In such cases, fine-tuning the degree of substitution is making a difference.

Figure 4 shows the correlation between the difference in a country ranking according to the CES function with a high compared to a low elasticity of substitution and country rankings according to the HDI index.

The differences are especially noticeable in the lower half of the HDI ranking distribution (see note to Fig. 4). Although the correlation, based on Kendall’s Tau, the correlation between the low and high substitution CES function is high (0.93), the average deviation between them (in absolute value) is 4. For 27 countries,

**Table 3 Countries with the ten largest negative differences between the WHR and ranking according to CES with low substitution between WHR and SDG index.**

Country	SDG rank	WHR rank	CESs low substitution	CESs high substitution
Bahrain	77	16	54	31
Ukraine	46	112	97	82
Tunisia	61	124	106	92
Guatemala	105	37	92	78
Saudi Arabia	87	26	70	57
Croatia	18	70	56	43
Nepal	86	77	73	85
Indonesia	90	82	77	89
Liberia	137	89	135	124
Bulgaria	38	91	76	66

the difference in ranking is statistically significantly different from zero.

Table 3 lists the ten countries with the largest differences between the HDI ranking and the CES functions and between the low and high elasticity CES functions. These are the most prominent anomalies. Most of the largest differences are cases where the subjective well-being is lower than the objective well-being.

We can clearly see that when large gaps in rankings exist between the subjective and objective indices, the low elasticity CES function ranks the country closer to its lower-performing index. For example, Hong Kong is ranked 5th according to the objective criteria as captured by the HDI index and only 68th according to the subjective well-being, WHR, index. The CES function with an elasticity of 0.1 penalizes this large gap by ranking Hong Kong 55th, whereas, with a higher degree of substitution, it would rank 33rd—a difference of 22 rank points.

The empirical results show that the rankings of countries are affected by using subjective and objective components (relative to adhering to only one component). Moreover, the data show that in terms of the CES social progress function, the differences are amplified if we assume a low elasticity of substitution.

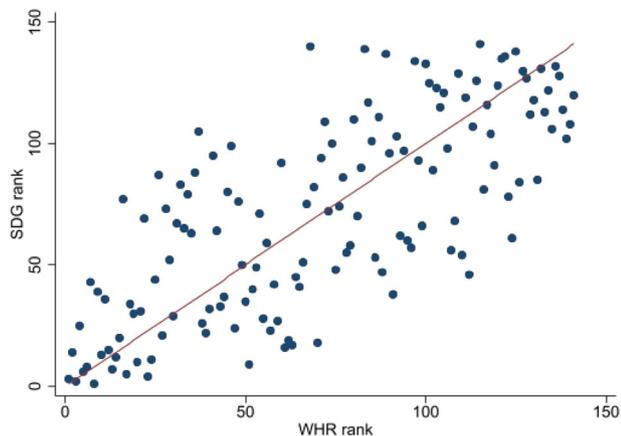
As explained, different indices may be favored to represent the components. We, therefore, experiment here also with the SDG Index as an objective component. This index represents a more recent comprehensive conception of social progress that includes other policy goals than ‘capabilities’ (however, its aggregation method is less developed than the HDI).

The differences between the HDI and SDG indices in scores are quite substantial: the overall rank correlation, using Kendall’s Tau, between them (based on 141 countries with available data) is 0.7. This high correlation is mainly driven by the top and bottom countries in the distribution. The correlation drops to 0.16 for countries ranked 35 to 75 according to the HDI index.

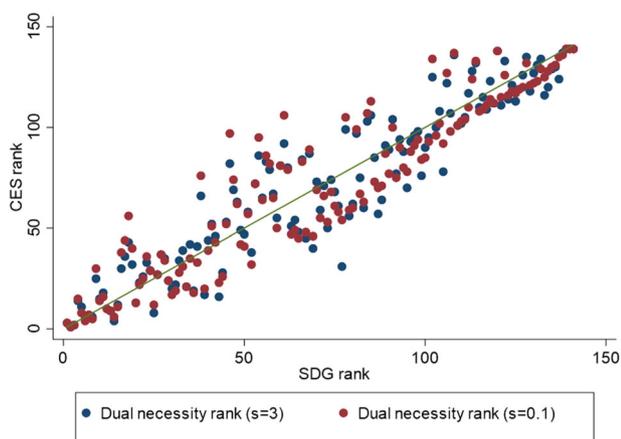
We can see that the main differences in ranking between the two measures are concentrated in the middle group of countries (See Fig. 5). As De Neve and Sachs (2020) found, the overall correlation between the SDG Index and WHR is high—0.91. However, when we compute the rank correlations it is much lower, at 0.53. Below the first quartile we can reject the hypothesis of a correlation between the rankings (see note to Fig. 5).

Figure 6 compares country rankings according to a CES function and an SDG index.

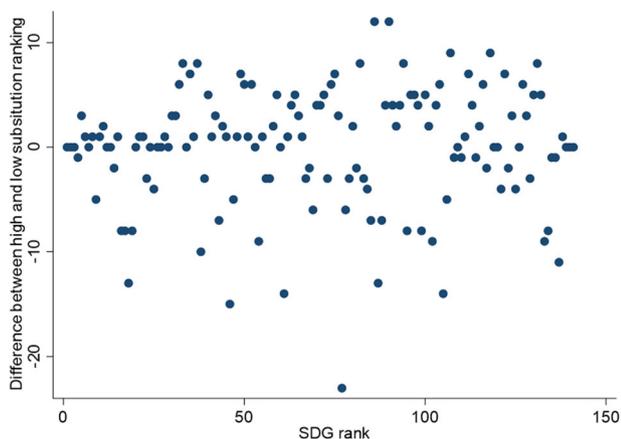
As in the case of the HDI index, although the correlation between the low and high substitution CES function is high (0.91), the average deviation between them in absolute value is 4 (Fig. 7). The differences are much higher in the 2nd and 3rd



**Fig. 5 The basic correlation between SDG Index and WHR rankings.** Rising dispersion below the rank of 25 in WHR. Rank correlations using Kendall tau (see appendix): all samples 0.53 and the quartile correlations based on WHR rank are: 1st 0.47; 2nd 0.02\*; 3rd 0.17\*; 4th 0.16\*. \* We can reject the null hypothesis of rank correlation at the 5% level.



**Fig. 6 Substitution (CES function) between SDG index and WHR compared to SDG index ranking.** The countries are ranked according to two dual necessity CES functions, one with an elasticity of substitution of 3 (high) and one with an elasticity of substitution of 0.1 (low). They are then plotted against their rankings according to the SDGs.



**Fig. 7 Differences in country rankings according to CES function with high and low substitution by SDG index ranking.** The quartile average differences between high and low substitution rankings (in absolute terms) are respectively: 1st 2.55; 2nd 4.31; 3rd 6.37; 4th 3.54. Quartiles based on HDI rank.

**Table 4 Countries with the ten largest deviations in rankings between HDI rank and CES with low substitution.**

Country	HDI rank	WHR rank	CESs low substitution	CESs high substitution
Hong Kong	5	68	55	34
Turkey	48	108	90	75
Sri Lanka	60	126	110	95
Botswana	79	135	131	117
Lebanon	76	131	117	104
El Salvador	97	28	79	66
Georgia	52	107	89	76
South Korea	22	62	43	32
Indonesia	87	82	75	86
Senegal	128	72	120	109

quartile of the distribution (see note to Fig. 7). For 26 countries, the difference in ranking is statistically significantly different from zero.

As we can see in Table 3, with the exception of Indonesia, the differences between the SDG rankings and the WHR rankings generate different anomalies than we showed in Table 4. This highlights the sensitivity to the index of choice for either subjective or objective measures. Moreover, we can see that the ten largest anomalies are almost evenly distributed between countries that have a higher SDG rank (6) and those that have a higher WHR rank (4).

**Discussion and conclusions**

The low substitution approach significantly impacts the assessment of social progress across various countries, compared to subjective or objective measures alone and to high substitution methods. This is evident in both the Human Development Index (HDI) and the Sustainable Development Goals Index (SDGI), despite the high overall correlations between subjective and objective indices across all sampled countries (see Figs. 2, 5).

The divergence is more pronounced in mid-range countries where the strong dual necessity conception and low substitution approach reveal many anomalies—countries in which these two approaches show considerable difference in ranking. These countries, we may add, make an interesting group when assessing social progress: for most of the leading states, as for the extremely backward states, there is not much question regarding their level of progress, and not much of a difference if we adhere to one conception and index of social progress or another.

These results expand those presented in previous research in two ways: they demonstrate how strong dual necessity is significant not merely for one random choice of indices, and they also demonstrate that experimenting with a low degree of substitution (instead of no substitution) makes a difference. The latter finding was made possible by using the CES function, which proved a useful instrument that allows social scientists and policymakers to implement different degrees of dual necessity.

A robust dual necessity concept and a limited substitution approach demonstrate the challenging demands for social progress, particularly in the instances of anomalies (refer to Tables 3 and 4). To illustrate, looking at Hong Kong, the ‘objective’ HDI index ranked the country at an impressive 5 in 2019. Yet, this ranking can be deceiving as it overlooks the subjective perspective—how individuals actually experience their lives. In this situation, an outlier in the subjective measure causes Hong Kong to be placed much lower, at 68th position(!). This discrepancy goes against our expectations, considering the typically strong correlation between objective and subjective elements. Understanding what factors contribute to this notably low subjective score in this specific case raises intriguing questions. In

every case, the answer could be different and demands a study (Ngoo et al., 2015, p. 148, point to ‘political instability’ as dominant explanatory factor in this case).

Regardless of the specific factors at play, combining a robust dual necessity and a minimal degree of substitution exposes society’s vulnerabilities. In the case of Hong Kong, this implies that despite its strong HDI score, its relatively lower WHR score ends up outweighing the former, resulting in a final ranking that may seem unexpectedly low. This is evident in Hong Kong’s rank of 55 in the low substitution index, whereas a higher substitution index places the city at 34 (Table 4). A comparable trend can be observed with other anomalies, such as Sri Lanka and Turkey in 2019.

The same goes with the opposite example, as in the case of Saudi Arabia and SDGI (Table 3). In this case, the relatively high rank of 26 in WHR neglects its backwardness in SDG’s objective standards (place 87). The low degree of substitution index posits it in place 70 (lower than the high substitution—place 57). A similar pattern is noticeable in the cases of Guatemala and the Philippines.

The key benefit of the low substitution index is its ability to encompass anomalies under one unified ranking, pinpointing weaknesses common to both cases. Unlike a high substitution index, this approach magnifies discrepancies between objective and subjective rankings. Consequently, it serves as a reminder for countries facing significant disparities in their rankings of objective versus subjective aspects to not overlook the lower rankings and address the underlying issues.

In particular, policies that enhance rankings in one dimension can no longer come at the expense of a lower ranking in another. For example, policies to increase employment rates among women in low and middle-income economies will likely enhance growth and other objective considerations. Still, if not carefully conceived and implemented, they may come at the expense of the subjective well-being of women and their families. A progress index with a high elasticity of substitution will not create the incentive to pursue policies that mitigate imbalances between objective and subjective elements of progress. The low substitution approach encourages policies promoting balanced progress, considering objective and subjective considerations.

Notwithstanding its advantages, the low substitution approach has noticeable limitations. First, when computing the score with this approach we assume comparability, the ability to put on one scale ‘apples and oranges,’ in this case, people’s experience of their lives and objective circumstances. Standardizing the indices partially addresses this issue. However, such criticism can be raised against many social progress indices, and against high substitution indices in particular. Indeed, in some contexts, a dashboard presentation that avoids this pitfall (see Table 2) is preferable, but in case of interest in one comprehensive ranking, a comparability assumption is required.

Second, the low substitution ranking alone does not indicate which of the two components drives a society down in the ranking. For instance, looking at Guatemala (refer to Table 3), to comprehend the reasons behind its relatively low score (ranked 92), one must first delve into its objective and subjective scores. Only then can an investigation into the drivers causing the lower score be initiated, which in this scenario is the objective score (the SDG Index, which is another index that demands unpacking!). Consequently, the index contains a wealth of data that is not immediately evident. This limitation is common to indices in general, as they function as succinct summaries of information. Therefore, with the goal of improving social progress, it is advisable to present the CES ranking alongside the constituent indices (as demonstrated in Tables 3 and 4).

The ultimate justifications for using a low substitution approach and the CES function would be if social scientists,

policymakers and international organizations actually regard the two kinds of considerations (subjective and objective) as highly significant and uncompromised *and* have preference for one comprehensive ranking. In such cases, the low substitution approach and the CES function allow the ‘sharpening’ of social progress measurements, and their robust representation.

We leave for further future research the challenges of identifying a myriad of contexts in which the same logic can apply and hence a low substitution and CES function are suitable. Such could be the evaluations of city towns, neighborhoods, schools, workplaces, etc. In addition, various subjective and objective indices could be tested in every context. Finally, while the current research has focused on ‘discriminant validation’ (Adcock and Collier, 2001, p. 540), other procedures of validation are welcomed, such as ‘nomological validation,’ i.e., testing if this method of measurement yields better behavioral predictions (for instance: patterns of immigration).

### Data availability

This article is based only on publicly available data. The data and the code used to generate the rankings are available at: <https://doi.org/10.5281/zenodo.13884429>.

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### Notes

- Scholarly and scientific works use different terms related to ‘social progress,’ such as ‘development,’ ‘quality of life,’ and others. For convenience, we use ‘social progress’ as an intentionally unspecified label in need of conceptual explication (this term is also used in the influential report of Stiglitz et al., 2009).
- This could be manipulated to enhance rankings (Lorenz et al., 2017).
- The view that social progress is equivalent with the sum of individuals’ subjective welfares.
- For example, with our approach and instrument, one could take the OECD better-life index (OECD, 2011) and implement the low substitution approach and CES function on it. This could be done by breaking the index into its subjective component (Life Satisfaction) and objective component (composed of the ten other indicators) and allowing only a low degree of substitution between them. This is not possible with the current index (which assumes a high degree of substitution). In this research, we favor indices that cover a broader group of countries, not only the OECD members.

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### Author contributions

The authors contributed equally to this work.

### Competing interests

The authors declare no competing interests.

### Ethical approval

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### Informed consent

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