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Is the European Social Progress Index robust? Implications for the design of European Union regional Cohesion Policy

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ABSTRACT

The European Social Progress Index (EU-SPI) is a composite index launched by the European Commission in 2016 to assess social progress. It is constructed using non-economic indicators, and is intended to serve as a tool for European regional policies. This paper shows that the 2020 release of the index is robust to multiple alternative designs, and thus suitable for policymaking. The EU-SPI and gross domestic product per capita (GDPpc) are positively correlated, although they are in no way substitutes. These findings suggest that the EU-SPI could complement the GDPpc as an instrument to determine eligibility and achieve a more citizen-oriented allocation of European Cohesion Policy funds.

KEYWORDS

European Cohesion Policy; European regions; social progress; uncertainty

JEL C43, F63, R11, R58
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1. INTRODUCTION

In the 1930s, the economist Simon Kuznets proposed gross domestic product per capita (GDPpc) as a suitable variable for assessing economic development; since then, this indicator has been widely used to evaluate not only economic but also social progress. From the outset, however, the limitations of GDPpc in this regard have been widely recognized. Even so, it was not until the 1970s that the first initiatives aimed at proposing more comprehensive indicators of economic and social development emerged. In the intervening years, more than 80 such measures have been proposed (Barrington-Leigh & Escande, 2018), covering economic and non-economic facets of development; for example, the Human Development Index (HDI) published by the United Nations since the 1990s, or the Better Life Index (BLI) proposed by the Organisation for Economic Co-operation and Development (OECD) in 2009.

A more recent initiative is the European Social Progress Index (EU-SPI) launched by the European Commission in 2016 to assess social progress in the European Union (EU). The EU-SPI, the latest edition of which is from 2020, is provided at the regional level and includes three dimensions that represent progressively more advanced features of social progress: basic human needs, foundations of well-being and opportunities. These dimensions are built by aggregating several components grounded on a wide array of raw statistical indicators. It should be noted that economic indicators are deliberately excluded from the EU-SPI, as it is intended to complement GDPpc as a tool for policymaking.

The EU has witnessed profound changes in recent decades. The great enlargements that took place from 2004 onwards have created a more complex and unequal Union, with severe economic and social inequalities between the early members and the newcomers. Therefore, understanding social progress disparities becomes crucial to the pursuit of a more socially integrated and cohesive Europe. In fact, the EU-SPI represents one of the European Commission's attempts to better understand the EU's reality and to provide policymakers and stakeholders with tools that can help them to design a more successful Cohesion Policy (Crescenzi et al., 2020; Fratesi & Wishlade, 2017). The European Commission's renewed policy guidelines for the period 2019–24 include, in addition to economic targets, other essential goals that matter for people's lives and social progress, some of which are closely related to features accounted for in the EU-SPI. These include a European Green Deal, a Europe fit for the digital age, the protection of the rule of law and a new push for European democracy.

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In spite of the great potential the EU-SPI offers for policymaking, the allocation of funds provided under the European Cohesion Policy mostly relies on regions' GDPpc. This may well be because the index is still fairly new, but also because its robustness needs to be proved. In fact, the European Commission encourages the scientific community to inform the EU-SPI developers about how to improve the index, and to provide guidelines on how to better measure social progress and ensure the uptake of the index by the regional governments. Composite indexes are comprehensive and very useful for summarizing; however, their construction relies on some subjective decisions regarding crucial issues such as the selection and normalization of raw indicators, the degree of compensability across components and aggregation methods (OECD, 2008). In this regard, if the assessment of social progress were significantly affected by altering the index construction parameters, the EU-SPI would be a poor policy instrument. Thus, policymakers would face a trade-off between allocating funds according to a simplistic but widely accepted indicator such as GDPpc, or considering more comprehensive indicators that better reflect people's reality, such as the EU-SPI, the robustness of which can be questioned.

The present paper feeds into this debate with two contributions. First, the robustness of the EU-SPI to different methodological choices in its construction is assessed by performing both local and global sensitivity and uncertainty analyses. Second, the paper provides an in-depth comparison of regions' social progress according to the EU-SPI and their level of economic development evaluated with GDPpc. Even though social progress displays a positive correlation with GDPpc, the former catches aspects for which income is likely to be a poor indicator; for example, there may be regions with high GDPpc but high levels of pollution, or relatively rich regions with modest performance regarding social rights. In particular, this paper assesses whether regions' eligibility status for funding under current EU regional Cohesion Policy according to their GDPpc holds on the basis of their social progress. In this regard, Döpke et al. (2017) found that the distribution of funds would be similar whether using GDPpc or an indicator based on the BLI. However, the EU-SPI is not only more comprehensive in terms of indicators than the BLI, but also more closely linked to the EU's regional reality and the European Commission's policy objectives. Moreover, this research goes beyond the abovementioned paper by identifying the dimensions of social progress which are more strongly related to GDPpc, thereby offering a better understanding of the facets of people's life that can sensibly be assessed by income, and those needing alternative indicators.

Beyond its interest for policymaking, assessing social progress is also of paramount importance for academics. One of the reasons is that geographical differences in dimensions of social progress such as opportunities might help to explain emergent political and socio-economic phenomena in Europe such as the distribution of the pro-Brexit vote, Eurosceptic attitudes or the recent surge of authoritarian populism. In this regard, the intuition provided by recent studies is that the geography of discontent and populism in Europe has been fuelled by the combination of a lack of opportunities and poor education (Becker et al., 2017; Dijkstra et al., 2020; Rodríguez-Pose, 2018).

Other scholars have shown that, in addition to the ability to make comparisons across territories and build rankings, the measurement of social progress also provides a novel tool for assessing its interplay with institutional indicators, traditional economic metrics and more holistic measures of human fulfilment. Fehder et al. (2019) show that improving the rule of law can have effects on social progress through the dimensions of access to education and information, health and environmental quality. Other papers have focused on the link between social progress and the growth of GDPpc, finding that economic growth is instrumental to achieve basic needs, but less so for other dimensions of well-being such as inclusiveness (Fehder et al., 2018; Pritchett, 2022). A recent paper by Peiró-Palomino et al. (2023) finds a worldwide convergence trend in basic human needs from the 1990s, which has run parallel to the convergence in income per capita; however, the world is not converging in foundations of well-being and, particularly, opportunities. These are examples of how building indexes of social progress, such as the EU-SPI, offers a constructive new research agenda aimed at exploring the two-way link between economic and non-economic factors shaping aggregate societal performance.

The results of this research yield interesting messages for both policymakers and academics. First, the EU-SPI is robust to multiple alternative designs, as the relative position of European regions according to their social progress barely changes. This is an important finding that points to the EU-SPI as a powerful instrument for policymaking. Second, the EU-SPI and GDPpc are positively correlated but they are in no way substitutes. In this regard, social progress offers a complementary view to income, particularly the dimensions of foundations of well-being and opportunities. Therefore, some dimensions of social progress related to more advanced social features could complement GDPpc as instruments to inform a more rational and citizen-oriented allocation of funds under European regional policies.

The remainder of the paper runs as follows. Section 2 sets out some background on the building of composite indexes. Section 3 explains the main methodological features of the EU-SPI and proposes some alternatives to test its robustness. Section 4 analyses the sensitivity and uncertainty of the index. Section 5 compares the EU-SPI with GDPpc, paying particular attention to the rankings of regions. Section 6 concludes and highlights how the results are of interest for policymakers and academics.

2. SOME BACKGROUND ON THE BUILDING OF COMPOSITE INDEXES

Composite indexes summarize the information gathered on multifaceted realities into a single figure, and allow

the comprehensible communication of complex phenomena to policymakers and the general public, for example, media or citizens. In addition, they are increasingly recognized as powerful tools for benchmarking the performance of territories in a variety of policy issues. However, composite indexes could also yield misleading messages if they are misinterpreted or poorly constructed. In this regard, their construction is subject to numerous methodological difficulties, and requires making subjective decisions.

According to the OECD (2008, pp. 15–16), the main steps involved in building a composite index are: (1) setting a theoretical framework for the selection of the single indicators making up the index; (2) selecting the indicators; (3) imputing missing data; (4) normalizing the indicators to render them comparable; (5) selecting the method of aggregation, paying particular attention to issues such as compensability; and (6) analysing robustness, that is, the sensitivity of the index to the inclusion or exclusion of single indicators, the way missing data are imputed, the normalization criteria or the aggregation approach. Given that subjective decisions in these stages could lead to different scores and rankings, an in-depth evaluation of the uncertainty surrounding the index is highly recommended (OECD, 2008, p. 117). This analysis should include an assessment of the sources of uncertainty and the setting of uncertainty bounds for both scores and rankings; and also determine which sources are more influential.

The usefulness of composite indexes for scholars in the field of regional science is confirmed by the number of indexes developed in recent years to deal with a range of topics across the EU's territories. In addition to the EU-SPI (Annoni et al., 2016) on which this research focuses, some of the most relevant for academics are noted below.

The European Regional Competitiveness Index (Dijkstra et al., 2011) was launched in 2010 and provides a picture of the competitiveness of EU regions. It is built from a number of indicators that capture issues relevant to productivity and long-run development, using the methodology of the Global Competitiveness Report (Schwab & Porter, 2007). The European Quality of Government Index (Charron et al., 2014) was also first released in 2010 and summarizes citizens' perceptions of and experiences with corruption, quality and impartiality of the essential public services of healthcare, education and law enforcement in their regions of residence. It is constructed from individual-level survey data, as described by Charron et al. (2021). These indexes have both exerted a notable influence on researchers in the field of regional science, as reflected by the numerous studies that have linked them to other socio-economic features of European regions.

Furthermore, the Composite Weighted Index of Regional Resiliency (Stanickova & Melecký, 2018) evaluates the economic resilience of European regions as the result of five dimensions: community links, human capital and sociodemographic structure, the labour market, economic performance, and innovation, science and research. The Female Achievement Index and the Female Disadvantage Index (Norlén et al., 2021) were both launched in 2021 by the European Commission to monitor gender equality and map the glass ceiling in EU regions. Other indexes are the Regional Entrepreneurship Development Index (László et al., 2013) and the Developing Regional Inclusive Society Index in the EU (Domínguez-Torreiro, 2016).

3. THE EUROPEAN REGIONAL SOCIAL PROGRESS INDEX (EU-SPI) PROJECT

The EU-SPI is a project developed by the European Commission that, generally, is aimed at assessing development and the quality of life of EU citizens. The index builds on the Social Progress Index produced by the non-profit organization Social Progress Imperative (Porter et al., 2014), and provides a consistent and comparable measure of social progress for the regions in the EU. It is grounded on a set of indicators that capture only social and environmental facets of social progress, thus excluding economic issues. These indicators measure outcomes rather than inputs, and they cover issues that can be directly addressed by policy intervention. Most of these indicators are inspired by the Natural Rights theory (Rousseau, 1762) and refer to rights that are not dependent on any particular culture, thus aspiring to be universal. The concept of social progress embodied in the building of the index also reflects, to some extent, a utilitarian value judgment, a Rawlsian view of justice or the liberal principle of equality of opportunity, characteristic of Western democracies.[1]

The project has a marked policy orientation, as it is intended to provide European policymakers and stakeholders with a benchmarking tool for assessing a broad range of social outcomes across EU regions. The EU-SPI is designed to facilitate the assessment of regions' strengths and weaknesses on social and environmental issues, most of which are at the heart of the investment supported by the EU's Cohesion Policy; these include access to information and communication technologies, energy efficiency, education and skills, and environmental pollution. The information provided by the EU-SPI – and its dimensions and components – can help policymakers to identify the best policy mix in their regions, target resources at the most problematic issues and fix clear and attainable objectives. This in turn can help the European Commission to deliver on its priorities embodied in initiatives such as The European Green Deal, A Europe Fit for the Digital Age or An Economy that Works for the People. It is worth noting that the EU-SPI is not currently intended for the purpose of funding allocation, and does not bind the European Commission in this regard.

The EU-SPI project also aims to contribute to the Beyond GDP agenda in the European regional context, as it assesses social progress as a complement to traditional measures of economic development. Furthermore, it is intended to support the achievement of the United Nations' Sustainable Development Goals.

3.1. Methodological issues of the 2020 EU-SPI and alternative proposals

To date, two editions of the EU-SPI are available, which were released in 2016 and 2020.[2] The 2020 release assesses social progress in 240 European regions at the NUTS-2 level, and is made up of 12 components measured by 55 raw indicators, with data primarily coming from Eurostat. Table 1 presents the hierarchical structure of the EU-SPI and lists all indicators, components and dimensions.[3] Annoni and Bolsi (2020, pp. 18–19) explain how the index is built.

Focusing on the methodological issues of the 2020 EU-SPI release, first, the indicators included in each component are selected after having verified with principal component analysis (PCA) (Rencher & Christensen, 2012) that there is strong multivariate correlation among them. In a second step, these indicators are normalized and converted to a common scale. The third step consists of aggregating indicators into components, and then the resulting components into three wider dimensions: basic human needs, including issues that are necessary but not sufficient to achieve social development; foundations of well-being, which include more advanced factors of social and environmental progress; and opportunities, representing more sophisticated facets of a cohesive and tolerant society. Finally, the three dimensions of social progress are aggregated into the EU-SPI.

The main methodological choices made by the European Commission in the stages of normalization and aggregation are described below; furthermore, some alternative approaches for testing the robustness of the index are proposed. These are the stages that involve the greatest subjectivity, where different choices could lead to notably different indexes of social progress and rankings of European regions.

3.1.1. Normalization of raw indicators

Raw indicators within each component of the EU-SPI have different measurement units; moreover, some of them have a positive relationship with social progress – for example, life expectancy – while with others the association is negative – for example, air pollution. In order to convert all indicators to a common scale and to ensure they are positively related to social progress, the min–max transformation with indicator-specific boundaries is applied.[4] These boundaries identify the best and worst performance on each indicator by any region, and they are set using utopian and dystopian values – when meaningful – or maximum and minimum scores across indicators' time series. The boundaries are described by Annoni and Bolsi (2020, pp. 23–25), and the normalized indicators are formally computed as:

$$I_{\text{normalized}} = \begin{cases} \dfrac{100\,(I - I_{\min})}{(I_{\max} - I_{\min})} & \text{if } I \text{ is positively oriented} \\ \dfrac{-100\,(I - I_{\min})}{(I_{\max} - I_{\min})} + 100 & \text{if } I \text{ is negatively oriented} \end{cases} \tag{1}$$

where $I_{\max}$ and $I_{\min}$ are, respectively, the upper and lower benchmarks for indicator I, and $I_{\text{normalized}}$ is the normalized score on a 0–100 scale.

This procedure allows the tracking of regions' absolute performance, as records for raw indicators are compared with utopian and dystopian values that represent desired objectives and undesired situations, respectively. Nevertheless, while benchmarks provided by the European Commission might be clear-cut for many indicators – for example, nobody would dispute that a desirable social goal is the proper treatment of wastewater – they may be debatable for others. To avoid subjectivity in setting these benchmarks, other normalization schemes can be used and their impact on the outcome assessed. In this regard, three alternative normalization approaches are considered; two are based on the min–max criterion – as is the EU-SPI– while the third follows a z-score standardization.

On the one hand, the min–max normalization is applied in two alternative scenarios. In the first, the indicator-specific benchmarks are set by the maximum and minimum values observed across the 240 regions included in the 2020 release of the EU-SPI, instead of using ad hoc utopian and dystopian values or historical records. In the second, observed maximum and minimum scores are also employed as the benchmarks, but extreme values are assigned to scores below and above 4th and 96th percentiles; in particular, values of 0 and 100, respectively, are assigned for positively oriented indicators, whereas for those with a negative orientation the values awarded are 100 and 0. Observations in between these two percentiles are normalized as in expression (1). This approach reduces the skewness of the distributions of raw indicators, also allowing for more evenly distributed indexes of social progress (OECD, 2018, p. 9). The third alternative normalization is the z-score standardization suggested by Greco et al. (2018), whose technical details are described in Appendix A in the supplemental data online.

It is worth noting that all three alternative normalization methods proposed allow the tracking of relative rather than absolute performance, since the benchmarks are set by observations from the raw indicators of regions in the sample. This feature can be seen as an advantage in that it means a source of subjectivity is avoided, as the reference points are entirely determined by the data with no value judgements required.

3.1.2. Aggregation and compensability issues

The 2020 release of the EU-SPI employs a hybrid approach to aggregate indicators, components and dimensions. Components are first calculated using unweighted arithmetic means of the normalized indicators included in each of them as the aggregating approach. Generalized means are then employed to aggregate components into dimensions, and dimensions into the EU-SPI.[5] In this regard, the internal consistency of indicators within each component mitigates the effect of different weighting schemes on the computation of the aggregate components (Decancq & Lugo, 2013), also reducing compensability across indicators; that is, the undesirable offsetting of poor scores in some indicators with high ones in others. Conversely, the effect of compensability is expected to

Table 1. The 2020 European Social Progress Index (EU-SPI): dimensions (D), components (C) and indicators (I).

D1. Basic human needs	D2. Foundations of well-being	D3. Opportunities
C1. Nutrition and basic medical care	*C5. Access to basic knowledge*	*C9. Personal rights*
I1. Mortality rate before 65	I17. Upper secondary enrolment rate age 14–18	I34. Trust in the national government
I2. Infant mortality	I18. Lower secondary completion rate	I35. Trust in the legal system
I3. Unmet medical needs	I19. Early school leavers	I36. Trust in the police
I4. Insufficient food		I37. Active citizenship
	C6. Access to information and communications	I38. Female participation in regional assemblies
C2. Water and sanitation	I20. Internet at home	I39. Quality of public services
I5. Satisfaction with water quality	I21. Broadband at home	
I6. Lack of toilet in dwelling	I22. Online interaction with public authorities	*C10. Personal freedom and choice*
I7. Uncollected sewage	I23. Internet access	I40. Freedom over life choices
I8. Sewage treatment		I41. Job opportunities
	C7. Health and wellness	I42. Involuntary part-time/temporary employment
C3. Shelter	I24. Life expectancy	I43. Young not in education, employment or training
I9. Burden cost of housing	I25. Self-perceived health status	I44. Corruption in public services
I10. Housing quality due to dampness	I26. Cancer death rate	
I11. Overcrowding	I27. Heart disease death rate	*C11. Tolerance and inclusion*
I12. Adequate heating	I28. Leisure activities	I45. Impartibility of public services
	I29. Traffic deaths	I46. Tolerance towards immigrants
C4. Personal security		I47. Tolerance towards minorities
I13. Crime	*C8. Environmental quality*	I48. Tolerance towards homosexuals
I14. Safety at night	I30. Air pollution NO2	I49. Making friends
I15. Money stolen	I31. Air pollution ozone	I50. Volunteering
I16. Assaulted/mugged	I32. Air pollution pm10	I51. Gender employment gap
	I33. Air pollution pm2.5	
		C12. Access to advanced education and LLL
		I52. Tertiary education attainment
		I53. Tertiary enrolment
		I54. Lifelong learning
		I55. Female lifelong education and learning

Note: LLL, lifelong learning.

be more marked across components, and particularly across dimensions. The generalized mean helps to mitigate this effect through the use of a family of functions to aggregate components and dimensions. Formally, the score for dimension j – either basic human needs, foundations of well-being or opportunities – in region r is computed as:

$$D_{jr}^{(\beta)} = \begin{cases} \left(\frac{1}{q}\sum_{i=1}^{q} C_{ir}^{\beta}\right)^{\frac{1}{\beta}} & \text{for } \beta \neq 0 \\ \left(\prod_{i=1}^{q} C_{ir}\right)^{\frac{1}{q}} & \text{for } \beta = 0 \end{cases} \quad (2)$$

where C_{ir} is the observed component i within dimension j in region r; and β is a parameter that can be adjusted to control for the level of compensability.

The EU-SPI can be easily calculated for each region by replacing components with dimensions in expression (2). In both cases, dimensions and the EU-SPI, β is set to 0.5, which allows for partial compensability.

As mentioned above, compensability means that a deficit in one component or dimension of the EU-SPI can be offset by a surplus in another. However, it seems logical that a region will only enjoy an acceptable level of social progress if it performs reasonably well across all its facets; that is, a deficiency in one particular determinant of social progress could lead to poor overall social progress, regardless of whether the region performs well in all the others. As noted above, the EU-SPI sets the parameter β to 0.5 in order to avoid full compensability. This research investigates the effect of different degrees of compensability – represented by the values of 0, 0.25, 0.75 and 1 for β – on the scores of social progress and rankings of regions, while still using the generalized mean to aggregate indicators. When this parameter equals 0, the generalized mean converges to the geometric mean and components (dimensions) would not compensate one another. Conversely, when $\beta = 1$, the generalized mean meets the arithmetic mean guaranteeing full compensability. The scores of 0.25 and 0.75 represent intermediate scenarios.

Beyond considering different degrees of compensability in the framework of generalized means as the aggregation approach, it makes sense to test for the effect of using other aggregating schemes on the assessment of social progress. In this regard, this research considers three alternative approaches to aggregate components into dimensions,

and dimensions into the EU-SPI: (1) principal components analysis (PCA); (2) data envelopment analysis and multicriteria decision-making (DEA-MCDM); and (3) the technique for order preference by similarity to ideal solution (TOPSIS). For technical details about these approaches, see Appendix A in the supplemental data online.

PCA aggregates the components included in each dimension of social progress – and the dimensions in the EU-SPI – into a single factor or principal component that captures the maximum amount of variance in the data while reducing redundant information. An advantage of this approach is that largest weightings are assigned to the indicators that have the largest variation across regions (OECD, 2008, p. 26). In this research, two scenarios regarding PCA are proposed. In the first – simply called PCA – both the dimensions and the EU-SPI are calculated using this aggregation technique. The second scenario follows the approach of the Social Progress Imperative (Stern et al., 2018), which consists of aggregating components into dimensions using PCA, and dimensions into the EU-SPI using a simple average; this weighting scenario is labelled PCA-equally weightings.

DEA is a technique initially developed to assess productive efficiency (Charnes et al., 1978), which was adapted for building composite indicators by Lovell et al. (1985). A noteworthy feature of DEA is that weightings are endogenously computed at the regional level based on the benefit-of-the-doubt principle (Cherchye et al., 2007); that is, self-weightings are awarded to each region so that they maximize its performance when it is compared with all other regions in the sample using the same set of weights. The OECD (2008, p. 101) cites this feature as a strength of DEA, as it avoids a source of subjectivity. However, the idiosyncratic nature of weights makes it difficult to rank regions (Kao & Hung, 2005). To overcome this limitation, DEA scores of regions' performance – which in this research are computed using the slacks-based approach proposed by Reig-Martínez et al. (2011) – have been combined with MCDM to provide a common set of weights for components and dimensions across regions, thus greatly facilitating comparisons. This combined approach is labelled DEA-MCDM.

Finally, TOPSIS is a compensatory multicriteria aggregation method proposed by Hwang and Yoon (1981), which involves setting two references within each component in a given dimension – the so-called positive and negative ideal solutions. The aggregate dimension for each region is then calculated as a function of the relative distance of the components to these benchmarks; and similarly for the construction of the EU-SPI itself. A couple of advantages of this approach are that it is straightforward and that all the available information is used to calculate the scores of social progress.

4. SENSITIVITY AND UNCERTAINTY ANALYSES OF THE EU-SPI

As shown in section 3, composite indicators can be thought of as models where several layers of uncertainty simultaneously coexist due to subjective choices made during their construction (Nardo et al., 2005; Saltelli et al., 2010). Therefore, outcomes from the EU-SPI – such as social progress scores or rankings of regions – are inherently uncertain. As such, once this uncertainty is acknowledged, they are no longer simple numbers but rather become a distribution of values. However, if the measurement of social progress were subject to a large degree of uncertainty and sensitivity, it would compromise the validity of the EU-SPI, thus lessening its usefulness for policymaking (Saisana et al., 2011). In order to test its robustness, this section examines the degree of uncertainty in the construction of the EU-SPI and its sensitivity.

As previously discussed, four approaches have been considered for the normalization of raw indicators in the EU-SPI, and nine in the aggregation stage – including in both cases those used by the European Commission. Accordingly, a total of 36 indexes of social progress and its dimensions have been computed;[6] this yields fairly manageable model configurations and makes it possible to work with the entire distribution of the scores and rankings without resorting to computationally burdensome Monte Carlo sampling techniques (Dialga & Thi Hang Giang, 2017). Using these computations as inputs, a first local sensitivity analysis is carried out, aimed at assessing the response of social progress outcomes to single changes in the construction of the index; that is, changing one choice at a time, while keeping all other choices constant (Xu & Gertner, 2008). Global uncertainty and sensitivity analyses are also performed, following Saisana et al. (2005) and Saltelli et al. (2008).

4.1. Local analysis of sensitivity

The local analysis of sensitivity focuses, as mentioned above, on assessing how the scores of social progress and rankings of European regions may differ after changing a particular choice in the construction of the EU-SPI, but leaving all other choices unchanged. Accordingly, the index has been recalculated considering – one at a time – all the alternatives described in section 3 regarding normalization and aggregation stages.

Figure 1 depicts the distributions of the EU-SPI scores of social progress obtained in each case, which have been computed with Gaussian kernel density functions (Henderson & Parmeter, 2015). This non-parametric approach allows data-driven analysis of the entire distribution of the scores of social progress. At first glance, the distributions of social progress calculated with the three alternative normalization criteria proposed seem to be different to the distribution from the original EU-SPI (Figure 1, panel a), as are the distributions when social progress is assessed using other criteria of aggregation (Figure 1, panel c). Conversely, assuming different compensability criteria in the aggregation stage with generalized means does not seem to exert an effect on the shape of the distributions of social progress (Figure 1, panel b). However, the statistical significance of these perceived graphical differences needs to be tested. To that end, both the non-parametric Kolmogorov–Smirnov test (Conover, 1999) and the Li

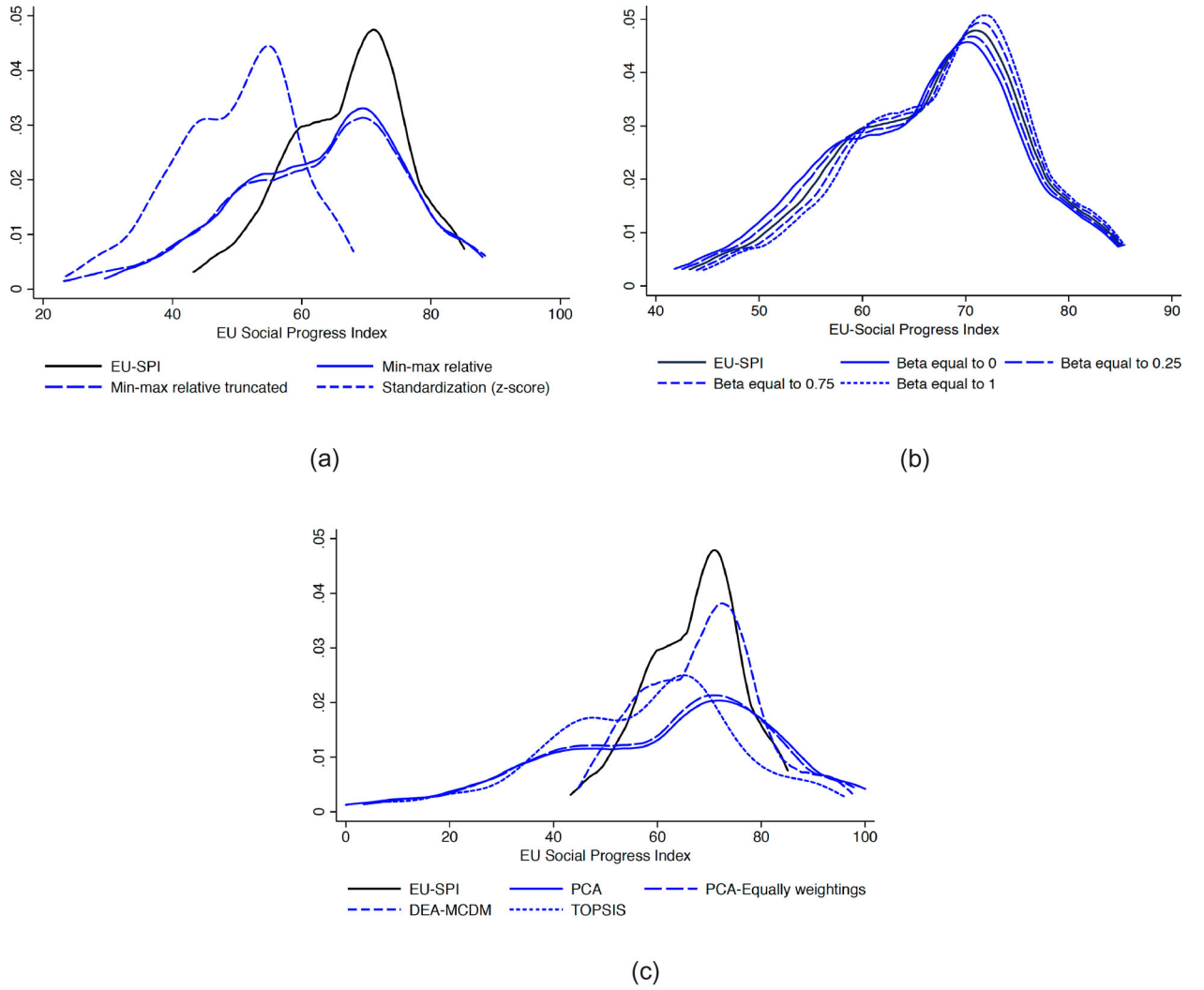


Figure 1. Distributions of the European Social Progress Index (EU-SPI) calculated with different criteria.

test (Li, 1996) are employed; the null hypothesis is always the equality of distributions. The results presented in Table 2 show – at standard confidence levels – that the distributions are statistically different for normalization and aggregation; however, they are not when other degrees of compensability are assumed.[7]

Furthermore, it has been tested whether social progress scores calculated with alternative criteria yield rankings of European regions similar to those from the original EU-SPI. To do so, Spearman and Kendall correlations have been calculated (Conover, 1999). Their interpretation is straightforward: the correlation between the scores of social progress from the EU-SPI and those computed using a different criterion will be high when regions have a similar rank – or relative position – in both distributions. Results in Table 2 show that, in spite of the fact that different normalization and aggregation criteria lead to different distributions of the scores of social progress, rankings of regions are not statistically different. In this regard, the average change – which summarizes the relative shift in the position of the entire set of regions into a single figure – ranges from five to eight positions in the ranking when alternative normalization criteria are used; from only one to two with different compensability criteria; and from five to 17 with other aggregation approaches.

4.2. Analysis of global uncertainty and sensitivity

The analysis of global uncertainty is performed by computing metrics of relative uncertainty – coefficient of variation – and absolute uncertainty – standard deviation – of social progress scores and rankings of regions across different designs of the EU-SPI. The results in Table 3 reveal that relative uncertainty is, on average, 1.7 times lower for rankings than for scores of social progress; the coefficients of variation are 10.9% and 19.1%, respectively. Regarding absolute uncertainty, the standard deviation for the rankings is 8.3 positions, whereas for the scores this figure reaches 10.1 points. These simple figures suggest that, on average, measures of social progress from the EU-SPI are rather robust. However, there is some heterogeneity in the degree of uncertainty across the 240 European regions included in the 2020 release of the EU-SPI.

Table 2. Distributions of social progress and rankings of regions from the European Social Progress Index (EU-SPI) and alternative indexes.

	Distributions of social progress		Rankings of regions	
	Kolmogorov–Smirnov (KS) test[a]	Li test[b]	Spearman's rank correlation test[c]	Kendall's rank correlation test[d]
Normalization				
Min-max relative	0.195***	6.114***	0.995***	0.950***
Min-max relative truncated	0.216***	7.133***	0.993***	0.939***
Standardization (*z*-score)	0.687***	80.420***	0.996***	0.914***
Aggregation				
Generalized mean and degree of compensability				
Beta = 0 (fully non-compensatory)	0.095	0.993	0.999***	0.978***
Beta = 0.25	0.066	0.249	0.999***	0.989***
Beta = 0.75	0.066	0.270	0.999***	0.988***
Beta = 1 (fully compensatory)	0.095	1.085	0.998***	0.978***
Other aggregation methods				
Principal components analysis (PCA)	0.287***	28.212***	0.989***	0.917***
PCA-equally weightings	0.291***	24.067***	0.990***	0.921***
DEA-MCDM[e]	0.137**	3.612***	0.936***	0.799***
TOPSIS[f]	0.337***	26.315***	0.995***	0.948***

Note: [a]KS-statistic for the null hypothesis of equality of distribution functions; exact *p*-values are computed.
[b]Li-statistic for the null hypothesis of equality of distributions.
[c]Spearman-Rho correlation.
[d]Kendall-Tau correlation.
[e]DEA-MCDM = data envelopment analysis and multicriteria decision-making.
[f]TOPSIS = technique for order preference by similarity to ideal solution.
*** and **Statistical significance at 1% and 5%, respectively. The reference is always the original EU-SPI.

Figure 2 plots the median of social progress across all the alternative designs of the index, the 95% confidence interval for each region, and their rankings in the original EU-SPI. The proximity between the outcomes from the baseline EU-SPI (solid line) and the median across indexes (dashed line) is considered a measure of accuracy and robustness, as the median is an unbiased estimator of central tendency. Regarding the distribution of regions' rankings in Figure 2 (panel a), relative positions from the baseline EU-SPI always lie within the 95% confidence interval, and closely follow the median rank. Put simply, the design adopted by the European Commission for building the EU-SPI yields a robust ranking of regions, as their relative positions would not be very different if other normalization and aggregation criteria were used. In fact, for a third of the regions the deviation of the EU-SPI ranking with respect to the median rank is less than or equal to one position, and for 70% of the regions it does not exceed five positions (Tables 4 and 5).

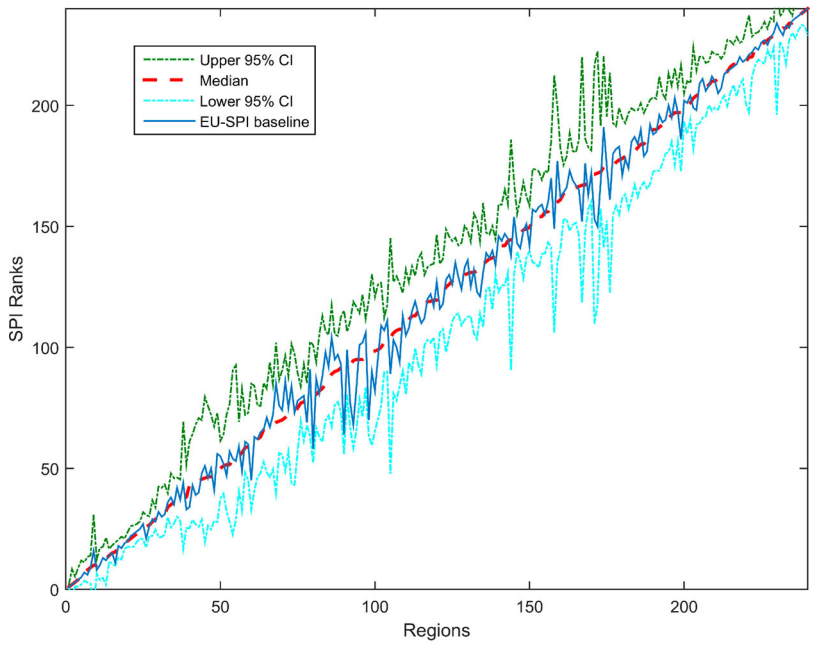
Table 3. Uncertainty in the measurement of social progress.

	Rankings	Scores
Coefficient of variation (%)	10.9	19.1
Standard deviation	8.3	10.1

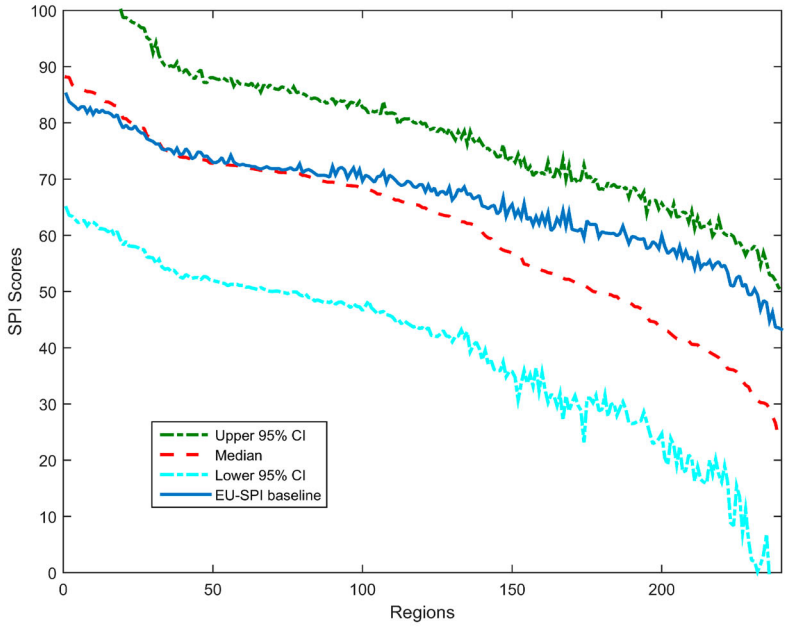
Note: The sample coefficient of variation and standard deviation are both calculated over all potential index designs and over all regions.

Likewise, the scores of social progress from the EU-SPI seem quite robust in the upper-middle part of their distribution, as they are close to the median score (Figure 2, panel b). Nevertheless, the divergence is more marked in the bottom of the distribution, suggesting that regions with medium to low scores are strongly favoured by the original EU-SPI, and that other normalization and aggregation criteria would tend to lower their scores of social progress. This finding reinforces the information provided in Table 3, which suggested that the measurement of rankings is more robust than that of scores.

As a further assessment of uncertainty in social progress measurement, Figure 3 maps the distribution of the standard deviation of the ranking awarded to the 240 regions included in the EU-SPI across indexes. Regions in countries of the Eastern and Southern peripheries of the EU – Bulgaria, Romania, Hungary, Italy and Greece, among others – display remarkably low variability, irrespective of how the index is computed; this is also the case in Sweden and Finland. These results suggest that rankings are robust in places where social progress is either very high or very low. However, uncertainty increases in regions with medium social progress. In summary,



(a)



(b)

Figure 2. Measurement of uncertainty across rankings and scores of social progress.
Note: Regions are ordered in both panels according to their average rank (score) across all designs of the European Social Progress Index (EU-SPI).

whereas there is some variability in terms of scores, ranks are fairly stable; that is, scores respond similarly to changes in the index-building parameters and cross-regional disparities in social progress are still visible. Accordingly, the EU-SPI can be judged as suitable for policymaking in that potential policies based on the index would not be shaped by its design. And what is more important, if the EU-SPI were used for allocating funds from the European Cohesion Policy, eligible regions would be virtually the same irrespective of its construction strategy.

Moving now to the sensitivity analysis, identifying the sources of variability in the outcomes from the EU-SPI might offer relevant information for the design of future releases of the index. In this regard, particular attention is paid in this research to the two central sources of uncertainty: data normalization and aggregation. In order to

Table 4. Rankings of social progress (50 top regions).

Region	EU-SPI rank	Median rank	95% Confidence interval
Övre Norrland (SE33)	1	1	[1,2]
Helsinki-Uusimaa (FI1B)	2	2	[1,2]
Mellersta Norrland (SE32)	3	3	[1,5]
Småland med öarna (SE21)	4	4	[1,8]
Länsi-Suomi (FI19)	5	7	[2,12]
Västsverige (SE23)	7	7	[4,11]
Midtjylland (DK04)	6	8	[3,13]
Pohjois-ja Itä-Suomi (FI1D)	9	9	[2,15]
Norra Mellansverige (SE31)	8	10	[7,13]
Östra Mellansverige (SE12)	10	10.5	[4,17]
Åland (FI20)	16	10	[1,30]
Etelä-Suomi (FI1C)	13	12	[5,18]
Stockholm (SE11)	12	12.5	[2,22]
Hovedstaden (DK01)	14	14	[12,17]
Sydsverige (SE22)	15	15	[11,19]
Nordjylland (DK05)	11	15.5	[10,20]
Utrecht (NL31)	18	17	[13,21]
Syddanmark (DK03)	17	18	[12,23]
Noord-Holland (NL32)	19	19	[17,21]
Groningen (NL11)	20	20	[18,23]
Zuid-Holland (NL33)	22	21	[17,25]
Flevoland (NL23)	23	22	[18,26]
Gelderland (NL22)	24	23	[20,27]
Sjælland (DK02)	21	26	[17,33]
Overijssel (NL21)	25	24	[21,28]
Friesland (NL12)	26	26.5	[22,31]
Noord-Brabant (NL41)	27	25	[21,31]
Drenthe (NL13)	28	29	[25,34]
Limburg (NL42)	29	28	[22,35]
Salzburg (AT32)	30	31	[22,41]
Zeeland (NL34)	32	30	[22,40]
Tirol (AT33)	31	31	[23,41]
Hamburg (DE60)	36	34	[30,39]
Southern (IE05)	35	36	[27,45]
Eastern and Midland (IE06)	38	35	[26,46]
Northern and Western (IE04)	37	37	[28,46]
Luxembourg (LU)	42	36	[30,44]
Bretagne (FRH0)	33	38	[25,51]
Oberösterreich (AT31)	44	38	[17,64]
Limousin (FRI2)	34	43	[25,61]
Rhône-Alpes (FRK2)	43	44	[29,62]
Midi-Pyrénées (FRJ2)	39	44.5	[27,65]
Pays de la Loire (FRG0)	41	46.5	[26,66]
Aquitaine (FRI1)	40	45	[26,67]
Navarra (ES22)	50	46.5	[25,70]
País Vasco (ES21)	48	45.5	[29,66]
Braunschweig (DE91)	55	50	[38,62]
Praha (CZ01)	51	46	[20,76]

(*Continued*)

Table 4. Continued.

Region	EU-SPI rank	Median rank	95% Confidence interval
Oberbayern (DE21)	56	48	[28,71]
Steiermark (AT22)	46	46.5	[26,71]

Note: Regions are ordered according to their average rank across all designs of the European Social Progress Index (EU-SPI).

Table 5. Rankings of social progress (50 bottom regions).

Region	EU-SPI rank	Median rank	95% Confidence interval
Kujawsko-Pomorskie (PL61)	189	191	[175,206]
Pest (HU12)	193	192	[179,205]
Sardegna (ITG2)	194	193	[182,204]
Piemonte (ITC1)	196	194	[173,212]
Região Autónoma da Madeira (PT30)	186	195	[179,213]
Stredné Slovensko (SK03)	200	196	[183,208]
Łódzkie (PL71)	197	197	[185,208]
Ipeiros (EL54)	195	198	[185,209]
Attiki (EL30)	203	199	[180,216]
Świętokrzyskie (PL72)	201	200	[189,211]
Abruzzo (ITF1)	202	201	[192,207]
Basilicata (ITF5)	204	202	[194,209]
Kriti (EL43)	198	203	[193,214]
Região Autónoma dos Açores (PT20)	199	204	[188,220]
Východné Slovensko (SK04)	209	205	[197,213]
Dél-Alföld (HU33)	206	206	[197,216]
Kentriki Makedonia (EL52)	211	207	[195,218]
Dytiki Makedonia (EL53)	208	208	[200,217]
Thessalia (EL61)	212	209	[199,219]
Dél-Dunántúl (HU23)	210	210	[201,219]
Voreio Aigaio (EL41)	205	211	[200,222]
Ionia Nisia (EL62)	207	212	[204,219]
Kontinentalna Hrvatska (HR04)	213	213	[206,220]
Puglia (ITF4)	214	214	[202,226]
Calabria (ITF6)	217	215	[207,225]
Anatoliki Makedonia, Thraki (EL51)	215	216	[208,224]
Észak-Alföld (HU32)	220	217	[209,226]
Dytiki Ellada (EL63)	216	218	[208,227]
Bucureşti–Ilfov (RO32)	219	219	[207,230]
Sicilia (ITG1)	218	220	[212,226]
Yugozapaden (BG41)	221	221	[206,236]
Peloponnisos (EL65)	222	222	[215,227]
Sterea Ellada (EL64)	224	223	[217,229]
Campania (ITF3)	223	224	[220,228]
Vest (RO42)	226	225	[220,230]
Nord-Vest (RO11)	227	226	[219,233]
Notio Aigaio (EL42)	225	227	[223,231]
Észak-Magyarország (HU31)	228	228	[223,234]
Mayotte (FRY5)	234	229	[210,240]
Centru (RO12)	230	230	[226,234]
Guyane (FRY3)	233	231	[219,240]

(*Continued*)

Table 5. Continued.

Region	EU-SPI rank	Median rank	95% Confidence interval
Severen Tsentralen (BG32)	229	232	[224,239]
Yuzhen Tsentralen (BG42)	231	233	[229,235]
Severoiztochen (BG33)	232	234	[228,240]
Sud-Vest Oltenia (RO41)	235	235	[232,237]
Nord-Est (RO21)	237	236	[234,238]
Yugoiztochen (BG34)	236	237	[234,239]
Sud-Muntenia (RO31)	238	238	[236,240]
Sud-Est (RO22)	239	239	[237,240]
Severozapaden (BG31)	240	240	[238,240]

Note: Regions are ordered according to their average rank across all designs of the European Social Progress Index (EU-SPI).

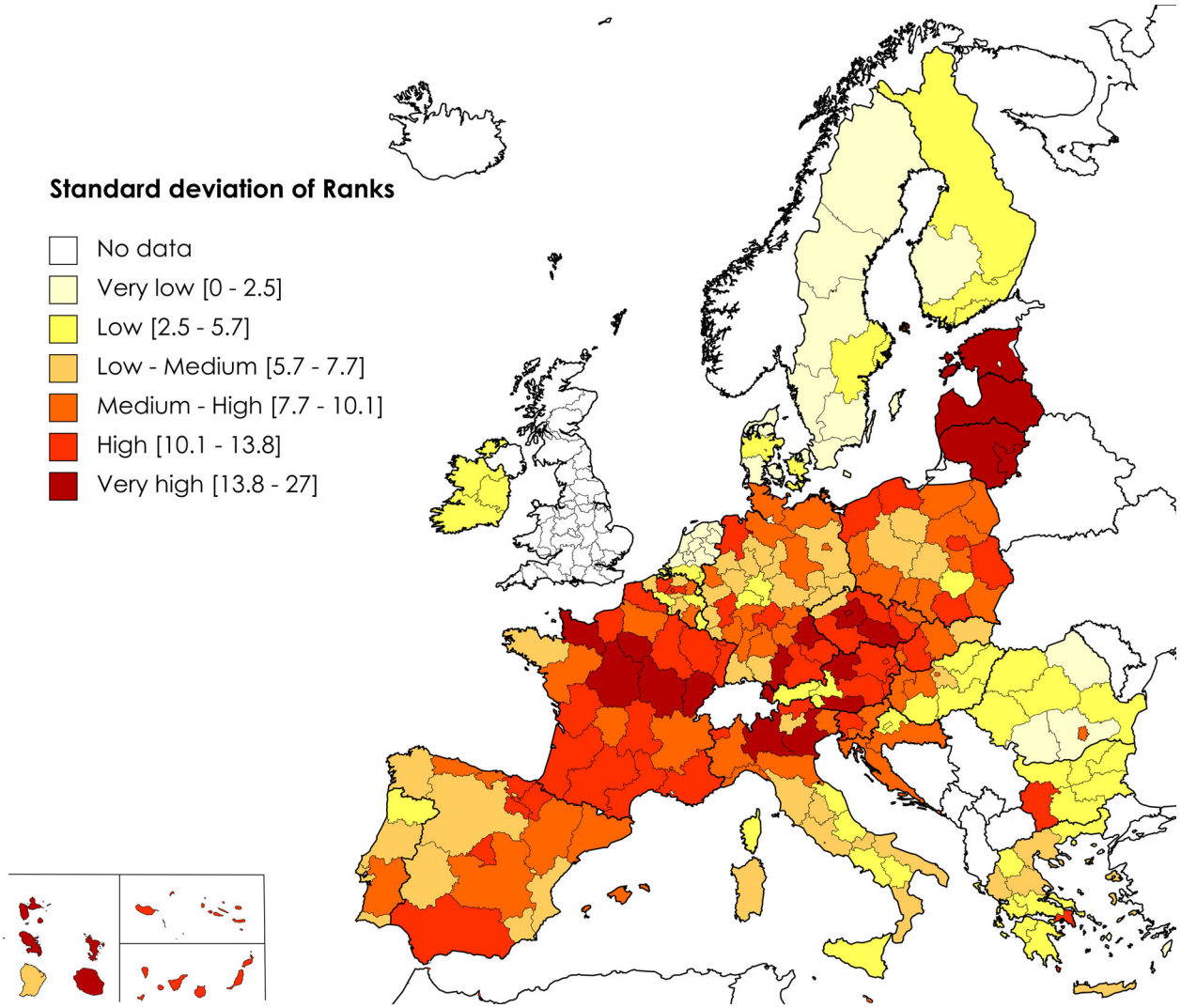


Figure 3. Rank uncertainty across European regions.

determine the contribution of these factors to total uncertainty, robust model-free variance-based techniques are employed to decompose the variance of the distributions of both the ranks of regions and scores of social progress (Saisana et al., 2005; Saltelli et al., 2008). For technical details of this approach, see Appendix A in the supplemental data online.

Table 6 displays Sobol's indexes (Sobol, 1993) and the total effect sensitivity indexes (Saltelli et al., 2008) for the average shift in regional rankings and scores of social progress with respect to the baseline EU-SPI. These figures suggest that aggregation has a larger influence on the variability of rankings than normalization, whereas just the opposite happens for the scores of social progress. At

Table 6. Indexes of sensitivity.

	Rankings		Scores	
	Sobol's index	**Total effect sensitivity index**	**Sobol's index**	**Total effect sensitivity index**
Normalization	0.03	0.86	0.26	0.96
Aggregation	0.14	0.97	0.04	0.74
Interaction	0.83		0.70	
Sum	1.00	1.83	1.00	1.70

any rate, taken independently these factors have only limited influence, as total variability is mainly driven by the interactions between normalization and aggregation, which account for 83% of the variance in rankings, and 70% in scores of social progress. These results can be useful when it comes to developing future editions of the EU-SPI, as they provide information about the implications of changing some of the index-building options.

5. COMPARING THE EU-SPI WITH GDPpc

The analyses performed in section 4 suggest that the EU-SPI is robust to different index designs and is thus appropriate for policymaking. Going beyond this central finding, this section presents a comparison between the original EU-SPI – including its three dimensions – and GDPpc. The aim is to determine whether they generate different insights in terms of rankings of regions and potential eligibility for funds allocated under the European Cohesion Policy. As a first step, correlations between GDPpc (measured with data from Eurostat in purchasing power standard (PPS); 2018) and social progress are all found to be positive and significant, although not particularly high; they reach 0.61 for the EU-SPI, and 0.52, 0.55 and 0.63 for basic human needs, foundations of well-being and opportunities, respectively. Accordingly, although GDPpc may represent social progress to some extent, there are aspects that it might fail to adequately capture.

Figure 4 provides scatter plots of the relationship between GDPpc and the scores of social progress from the EU-SPI, including its three dimensions; the EU-27 average is taken as a reference. The relationship is non-linear in all four cases: whereas the correlation is quite strong for low-income regions, once a sufficiently high level of income has been achieved, social progress stagnates. This pattern is especially apparent for basic human needs, for which the stagnation point is reached even at below-average income levels. However, this is to be expected in the European context, considering that even relatively poor regions have their basic needs covered. In the case of foundations of well-being and opportunities, a stagnation point is also reached; interestingly, regions with the highest levels in these two dimensions have income levels only slightly above the average.

5.1. Ranking regions with GDPpc and the EU-SPI

Beyond the above considerations, the point of comparing GDPpc and the EU-SPI is to determine whether both indicators yield similar results when it comes to ranking regions. In the framework of the Cohesion Policy for the period 2021–27, *less developed regions* with GDPpc levels in PPS below 75% of the EU average are particularly targeted for funding. *Transition regions* with GDPpc between 75% of the average and the average, and *more developed regions* whose GDPpc is above the average, also receive funds albeit to a lesser extent.

Ranking the 240 regions included in the EU-SPI according to their GDPpc shows that the top 92 are more developed, the next 68 are transition regions, and the last 80 are less developed regions. If the same grouping criterion were applied to the EU-SPI, only 11 regions would be classified as less developed – that is, regions with a level of social progress below 75% of the EU average. In contrast to GDPpc, for which there are several regions with extremely high values that notably drive up the mean and increase dispersion, social progress scores are more concentrated around the mean. Accordingly, to make comparisons meaningful, European regions have been sorted according to their EU-SPI by considering the same number of regions in each category as in the ranking based on GDPpc. Given that rankings from the EU-SPI are more stable than scores, this approach should yield a more robust comparison. Furthermore, using relative positions to classify regions makes much more sense in the framework of the EU-SPI. The reason for this is that whereas GDPpc measures a magnitude in monetary terms, the scores of social progress are not so easily interpreted, and rankings reflect disparities without the need for such interpretation.

These classifications are then used to compare which regions belong to the same category according to both GDPpc and social progress from the EU-SPI, thus allowing an assessment of how regions' ranks differ according to the two criteria. Table 7 summarizes the results for the EU-SPI and its three dimensions. The highest probability always corresponds to the outcome of regions sharing the same group, although other interesting observations emerge suggesting that GDPpc and social progress actually capture different facets of development. In this regard, 78.8% of the regions categorized as less developed according to GDPpc are classified in the same group by the EU-SPI, whereas the remaining would be considered either regions in transition (18.7%) or more developed regions (2.5%) according to their level of social progress. On the other hand, 69.6% of the regions classified as more developed in terms of income are also in this top category

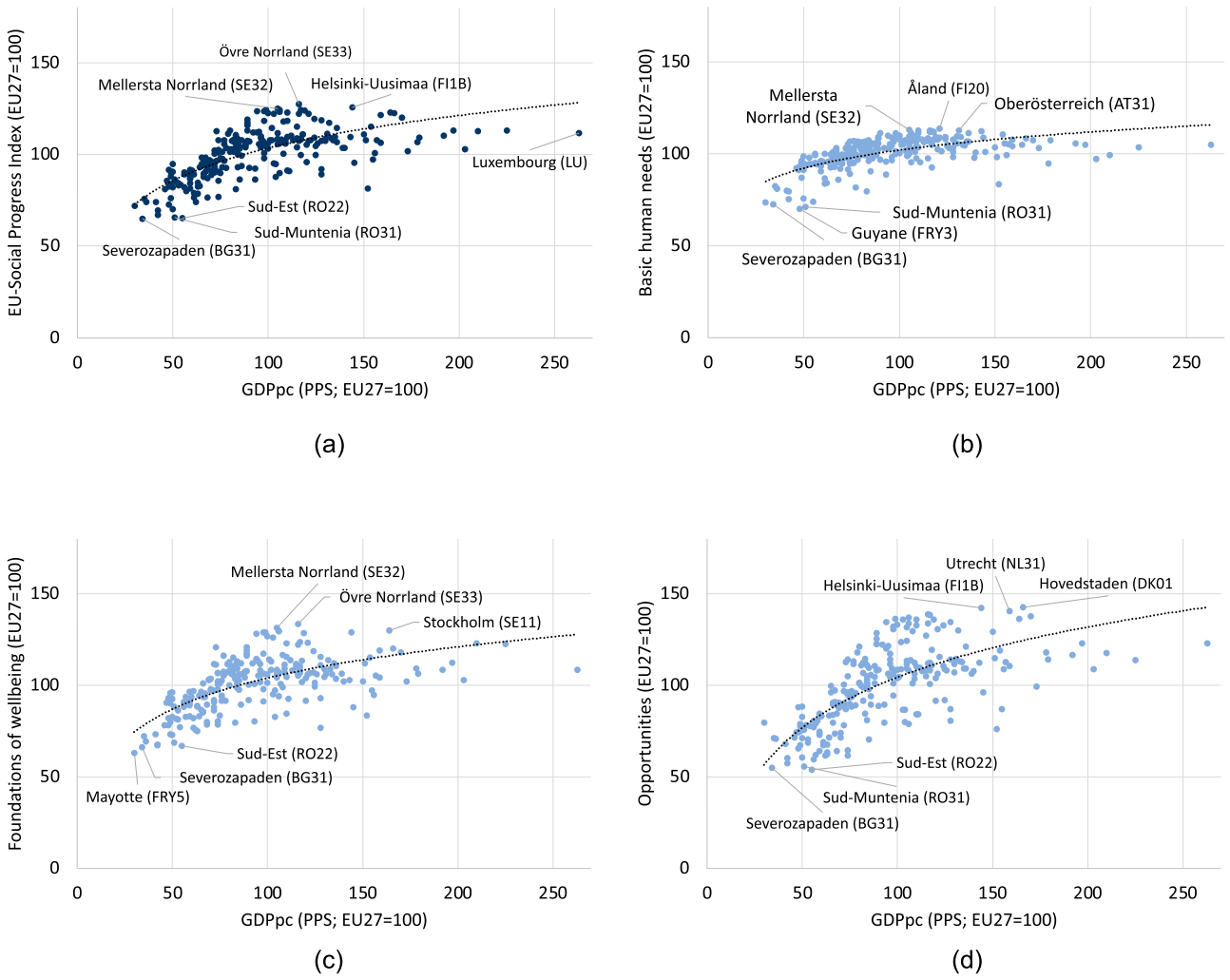


Figure 4. Gross domestic product per capita (GDPpc) versus the European Social Progress Index (EU-SPI) and its dimensions.

according to their social progress, while the remaining would be transition (22.8%) or less developed regions (7.6%). Results are similar for the three dimensions of social progress.

More interestingly, Figure 5 classifies the EU's regions by their potential eligibility for funds from the European Cohesion Policy according to their GDPpc, and then under the EU-SPI. Focusing on eligibility as *less developed regions*, the following four groups are considered: (1) eligible under both criteria (green); (2) non-eligible under both criteria (light blue); (3) eligible on the basis of GDPpc, but non-eligible according to the EU-SPI (yellow), labelled as *losers*; and (4) non-eligible according to GDPpc, but eligible on the basis of the EU-SPI (red), named *winners*.

Regions in the last two categories (listed in Table 8) are of particular interest for the purpose of this research. On the one hand, the *losers* are less developed regions because their GDPpc is below 75% of the average, but they would lose this status if eligibility were assessed with the EU-SPI. Seventeen regions fall into this group, with no clear geographical pattern. For instance, Northern and Western Ireland (IE04) is a less developed region according to its GDPpc (ranks 169th), but enjoys high levels of social progress (ranks 37th), particularly in dimensions such as environmental quality, tolerance and inclusion, and access to basic knowledge. Likewise, Lorraine (FRF3), which ranks 167th and 77th, respectively, is a less developed region according to its GDPpc but enjoys medium-high levels of social progress, mainly regarding tolerance and inclusion, personal rights and access to advanced education.

The *winners*, on the other hand, are regions non-eligible as less developed according to their GDPpc that would become eligible if funds were eventually allocated on the basis of the EU-SPI. Most regions in this category are in Italy; furthermore, some of them are home to large cities or the national capital. Examples are Bucureşti-Ilfov (RO32), which is home to the city of Bucharest and ranks 19th in EU regions according to GDPpc, and 219th for social progress; Attiki (EL30) is the home to Athens and ranks 111th and 203rd, respectively; also, Lazio (ITI4) ranks 66th and 178th, and is home to the city of Rome. Other Italian regions such as Lombardia (ITC4) – where Milan is located – Valle d'Aosta (ITI4), Piemonte (ITC1) and Liguria (ITC3) also rank high in terms of

Table 7. Gross domestic product per capita (GDPpc) versus social progress: probabilities matrix (%).

	GDPpc versus …			
Regions	**Basic human needs**	**Foundations of well-being**	**Opportunities**	**EU-SPI[a]**
More developed–more developed	66.3	58.7	67.4	69.6
More developed–transition	22.8	29.3	21.7	22.8
More developed–less developed	10.9	12.0	10.9	7.6
Transition–more developed	42.6	48.5	41.2	38.2
Transition–transition	57.4	51.5	58.8	61.8
Transition–less developed	0.0	0.0	0.0	0.0
Less developed–more developed	2.5	6.3	2.5	2.5
Less developed–transition	25.0	20.0	18.7	18.7
Less developed–less developed	72.5	73.7	78.8	78.8

Note: The matrix reports probabilities of mobility between groups considering their income.
[a]EU-SPI = European Social Progress Index.

GDPpc but low according to their social progress. Most of the abovementioned regions show very poor performance in dimensions of social progress as critical as environmental quality.[8]

In order to dig deeper into the drivers of the change in the rankings of regions according to GDPpc and the EU-SPI, two further complementary analyses have been carried out. They are grounded on the Bayesian model averaging (BMA) approach, which yields a probabilistic classification of the importance of the 12 components of social progress in explaining ranking differences; and relative importance (RI) techniques, which assess the relative

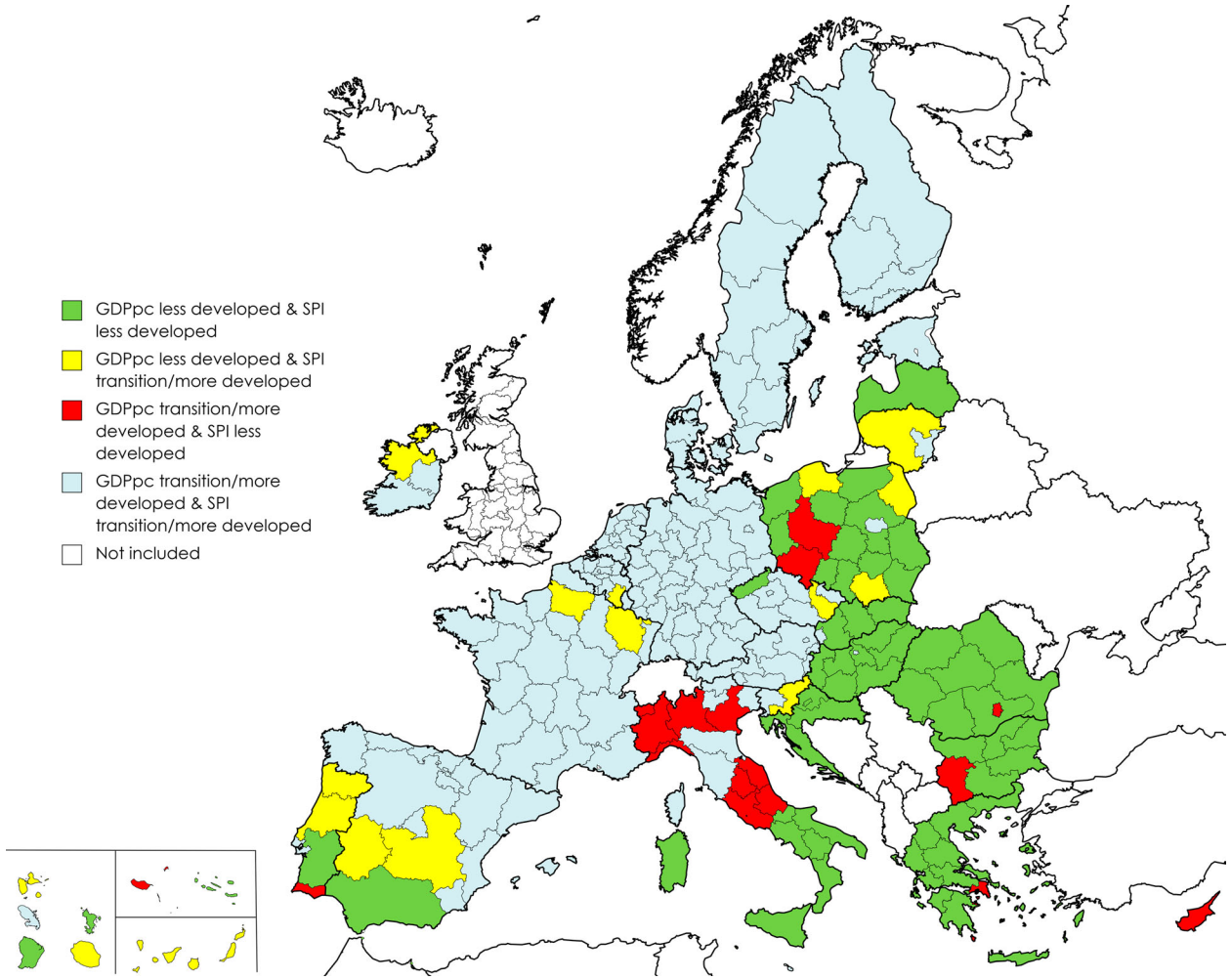


Figure 5. European regions according to gross domestic product per capita (GDPpc) and the European Social Progress Index (EU-SPI).

Table 8. Losers and winners from ranking regions with the European Social Progress Index (EU-SPI) instead of gross domestic product per capita (GDPpc).

Ranking			Ranking		
Losers	**GDPpc**	**EU-SPI**	**Winners**	**GDPpc**	**EU-SPI**
Northern and Western (IE04)	169	37	Bucureşti-Ilfov (RO32)	19	219
Lorraine (FRF3)	167	77	Lombardia (ITC4)	37	191
Podlaskie (PL84)	224	159	Valle d'Aosta (ITC2)	36	173
Norte (PT11)	192	142	Lazio (ITI4)	66	178
Luxembourg (BE34)	173	125	Piemonte (ITC1)	86	196
Centro (PT16)	186	141	Liguria (ITC3)	77	187
Picardie (FRE2)	166	124	Veneto (ITH3)	67	177
Vzhodna Slovenija (SI03)	175	136	Attiki (EL30)	111	203
Vidurio ir Vakarų Lietuvos (LT02)	190	153	Yugozapaden (BG41)	137	221
Střední Morava (CZ07)	164	128	Abruzzo (ITF1)	127	202
Extremadura (ES43)	185	151	Marche (ITI3)	112	172
Canarias (ES70)	165	131	Kýpros (CY)	114	168
Małopolskie (PL21)	191	158	Algarve (PT15)	124	163
Pomorskie (PL63)	180	148	Umbria (ITI2)	130	164
La Réunion (FRY4)	178	152	Madeira (PT30)	159	186
Guadeloupe (FRY1)	168	150	Dolnośląskie (PL51)	150	169
Castilla-La Mancha (ES42)	174	157	Wielkopolskie (PL41)	155	167

Note: Regions are ordered in each category according to the absolute value of the difference between rankings with GDPpc and the EU-SPI, in descending order.

contribution of each component to variability in the rankings. The technical details are shown in Appendix A in the supplemental data online; the empirical results are given in Table 9.

The findings from the BMA analysis reveal that the environmental quality component of social progress is a key predictor of the change in rankings when eligibility is assessed with the EU-SPI instead of GDPpc. This component has full probability of being part of the model, and exerts a quantitatively relevant impact on the difference in the rankings. Furthermore, the RI analysis brings to light the fact that environmental quality does most to explain differences in rank (40.9%); other relevant components are personal rights (9.4%), health and wellness (8.9%), and personal security (8.9%). These average results are consistent with the poor performance in environmental quality observed in the *winner* regions mentioned above, particularly those in the North of Italy. In this regard, the difference in ranks is largely explained by the fact that GDPpc does not account for an important externality of economic activity like air quality.

A final analysis is conducted in an effort to provide a more accurate view of regions' mobility. To that end, high-density plots are computed using conditional density estimation (Hyndman et al., 1996) and data relative to the sample mean. This technique is based on stochastic kernels and provides the probability of a region enjoying a specific level of relative social progress given its relative position in terms of income. The technical details are shown in Appendix A in the supplemental data online.

High-density plots are depicted in Figure 6, and their interpretation is straightforward. If the probability mass is distributed along the main diagonal, then relative positions in terms of income coincide with those according to social progress; also, the bars around each point – representing a region – denote 50%, 90% and 99% of the probability mass from the darkest to the lightest grey, respectively. With this in mind, Figure 6 (panel a) shows that the dispersion of the EU-SPI is lower for regions with a GDPpc more than twice the average, which enjoy levels of social progress slightly above the average. This finding reinforces the idea that social progress stagnates after a certain level of income. Conversely, the dispersion of social progress increases for the rest of the income levels. Focusing now on less developed regions, social progress could be expected to be far below the average in most of them, yet the dispersion is relatively high.

Regarding the dimensions of social progress, a very low dispersion is observed for basic human needs, which is only slightly larger for less developed regions (Figure 6, panel b). The dispersion increases for foundations of well-being, although regions with an income between 75% and 175% of the average are expected to maintain the same ranking (Figure 6, panel c). In the case of opportunities, however, the dispersion rises substantially with the exception of the group of richest regions (Figure 6, panel d). The relationship with income is more apparent for this dimension and the gap between poor and rich regions widens. A likely explanation is that opportunities represent most sophisticated facets of social progress,

Table 9. Determinants of the difference in rankings according to the gross domestic product per capita (GDPpc) and European Social Progress Index (EU-SPI).

	Bayesian model averaging (BMA) analysis				Relative importance (RI) analysis
	Posterior inclusion probability	Posterior estimates	Standardized posterior estimates	Posterior sign certainty	R^2 decomposition
Environmental quality	1.00	1.81***	0.49***	1.00	40.9%
		(0.26)	(0.07)		
Health and wellness	1.00	−2.27***	−0.46***	0.00	8.9%
		(0.49)	(0.10)		
Personal security	0.99	1.32***	0.19***	1.00	8.9%
		(0.34)	(0.05)		
Personal freedom and choice	0.97	−1.19***	−0.30***	0.00	2.9%
		(0.37)	(0.09)		
Access to advanced education and LLL	0.80	0.58***	0.22***	1.00	8.0%
		(0.21)	(0.08)		
Water and sanitation	0.70	1.04***	0.20***	1.00	3.1%
		(0.38)	(0.07)		
Shelter	0.62	1.53***	0.30***	1.00	6.8%
		(0.59)	(0.11)		
Personal rights	0.57	1.41**	0.28**	1.00	9.4%
		(0.57)	(0.11)		
Access to information and communications	0.12	−0.69	−0.14	0.09	2.8%
		(0.70)	(0.15)		
Access to basic knowledge	0.11	0.31	0.08	0.98	1.1%
		(0.32)	(0.08)		
Tolerance and inclusion	0.08	0.36	0.09	0.94	4.7%
		(0.57)	(0.15)		
Nutrition and basic medical care	0.07	−0.02	0.00	0.49	2.6%
		(0.66)	(0.12)		

Note: Standard deviations are shown in parentheses. **Significant at the 5% level and ***1% level. The dependent variable in all models is the rank of region *r* according to GDPpc minus its rank with the EU-SPI. Since a rank of 1 means top performance, positive values of this dependent variable mean a better rank with the EU-SPI than with GDPpc. Conversely, negative values imply a higher rank when using GDPpc. LLL, lifelong learning.

and a sufficient level of economic progress is needed to enjoy them.

As noted above, the results from the comparison of GDPpc and the EU-SPI support the idea that income and social progress are somewhat related but they actually represent complementary aspects of development. Accordingly, it seems sensible to suggest that the EU-SPI cannot substitute for GDPpc as a policy tool for determining the allocation of funds under the European Cohesion Policy. This research indicates that the two indicators can complement each other; as such, fund-allocation criteria grounded on both economic and non-economic issues would offer a much more accurate response to regions' development needs than a focus on GDPpc alone.

5.2 . How do GDPpc and the EU-SPI relate to other European regional features?

GDPpc has often been associated with relevant socio-economic outcomes such as the quality of institutions, income distribution or the gender gap. But how does social progress correlate with these and other facets of societies' performance? Table 10 and Figure 7 provide empirical evidence of the relationship in the EU's regions among GDPpc (in thousands PPS; 2018), the EU-SPI, and the last available releases of the EU regional indexes reviewed in section 2.[9] The Pearson correlation coefficients are all positive and statistically significant at 1%. Furthermore, the R^2 from a regression of each regional index on the EU-SPI – or GDPpc – show that both explain a large portion of the variance of the indexes across regions. These results suggest that higher levels of both income per capita and social progress in the EU's regions are associated with greater competitiveness, governments of higher quality, greater resilience and better female achievement. Noticeably, in all cases the link when using the EU-SPI is stronger than for GDPpc, which suggests that the EU-SPI is a powerful tool for analysing the relationship of social development with other important outcomes.

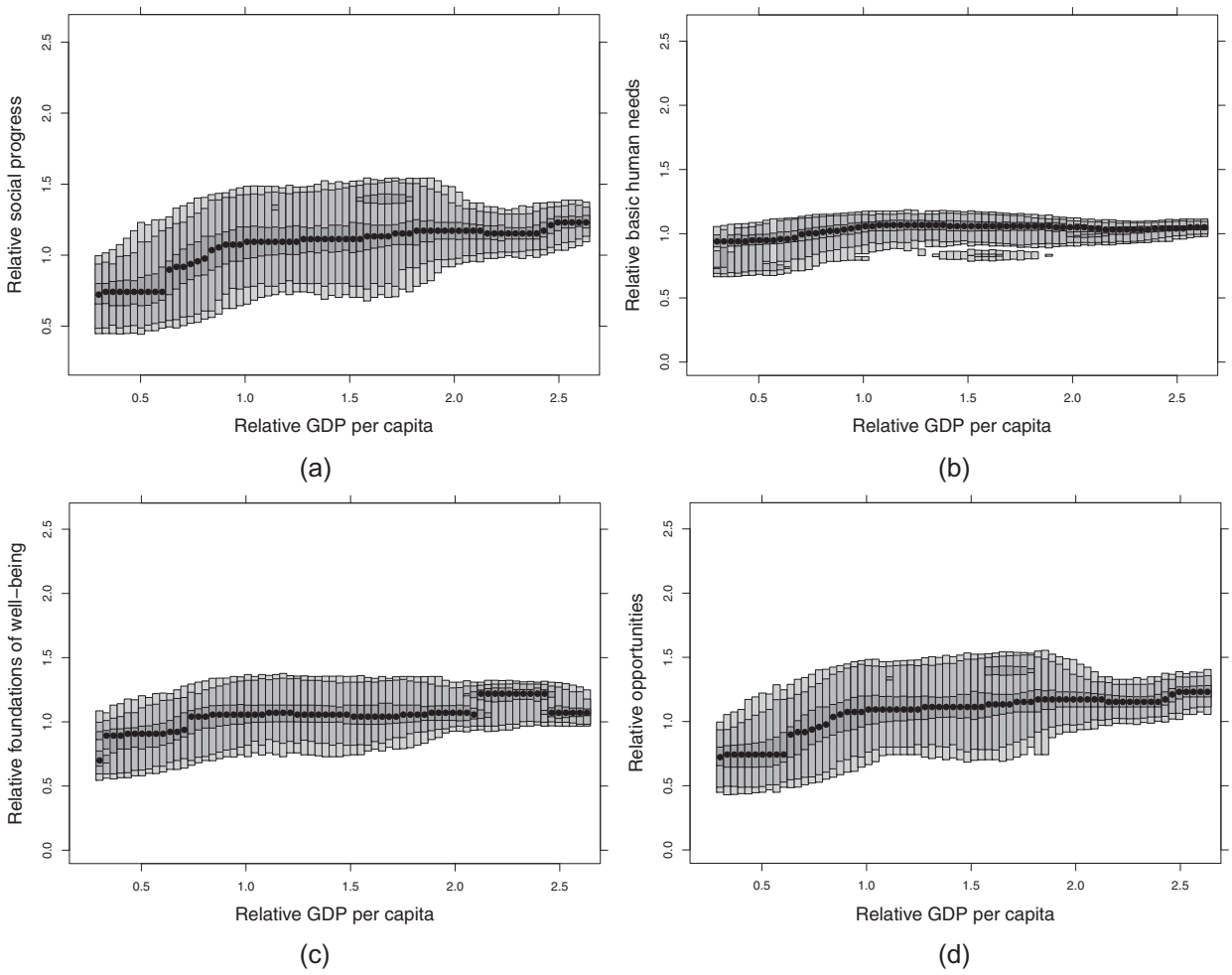


Figure 6. Gross domestic product per capita (GDPpc) versus the European Social Progress Index (EU-SPI) and its dimensions: high-density plots.

Table 10. Link between the European Social Progress Index (EU-SPI), gross domestic product per capita (GDPpc) and other European Union (EU) regional indexes.

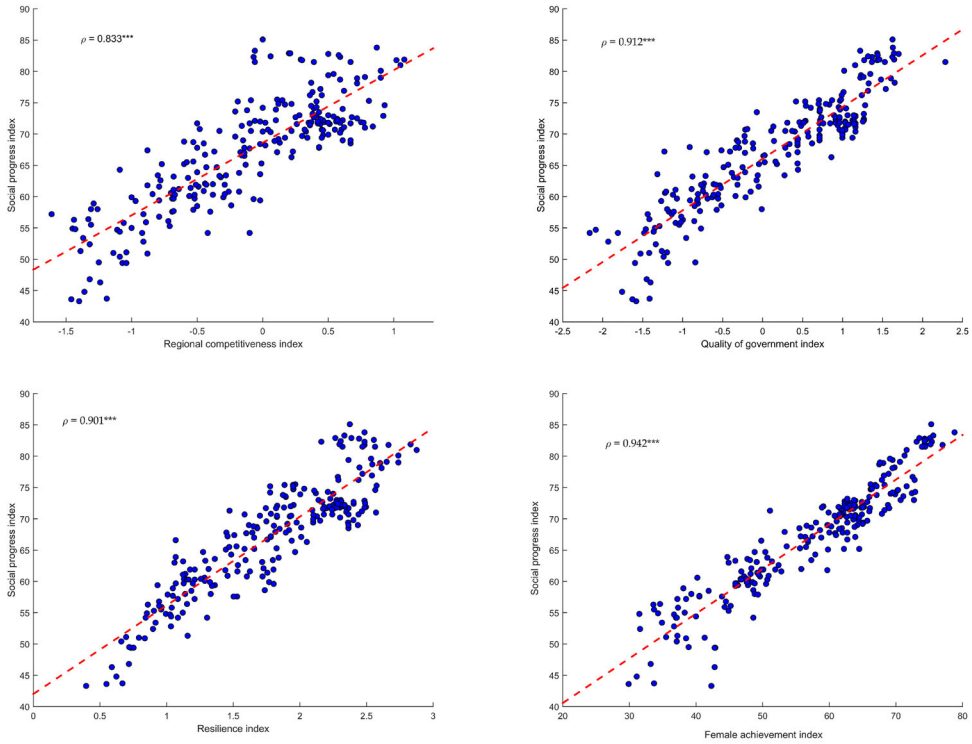
	EU-SPI (2020)		GDPpc (PPS; 2018)	
	Coefficient of correlation	R^2	Coefficient of correlation	R^2
Regional Competitiveness Index (2019)	0.833***	0.693	0.751***	0.564
Quality of Government Index (2021)	0.912***	0.831	0.531***	0.281
Resilience Index (2017)	0.901***	0.811	0.722***	0.521
Female Achievement Index (2021)	0.942***	0.887	0.592***	0.350

Note: R^2 from a linear regression of each regional index on the EU-SPI (or GDPpc).
***Significant at the 1% level. PPS, purchasing power standard.

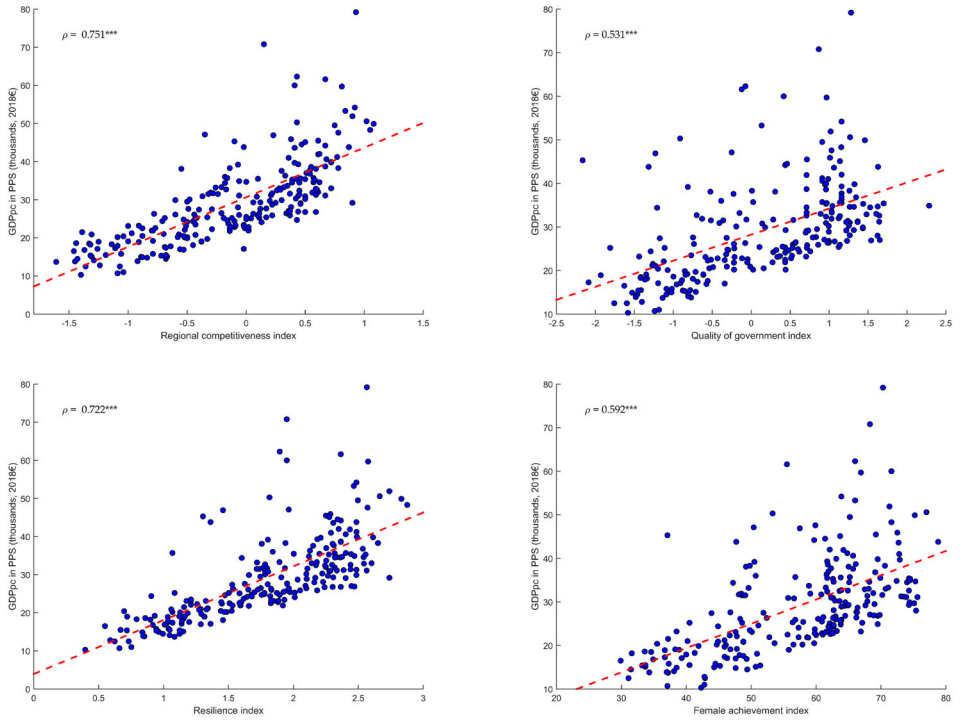
In addition, GDPpc and the EU-SPI are positively correlated with social trust – measured with data from the European Social Survey for the period 2010–14. The Pearson correlations are 0.497 and 0.728, respectively; both are statistically significant at 1%. The EU-SPI is also more correlated to regional income inequality – measured with the Gini Index for 15 EU countries from the OECD's Regional Wellbeing Dataset – than GDPpc. These results strengthen the idea that, as well as being of interest for policymaking, the EU-SPI is highly relevant for academic research.

6. CONCLUSIONS AND POLICY IMPLICATIONS

GDPpc is still the most commonly used indicator to assess both economic and social development. In recent decades, however, its limitations have spurred the rise in more sophisticated measures accounting for dimensions of development that go far beyond economic issues and matter greatly for people's lives. A salient initiative is the EU-SPI developed by the European Commission to assess regions' social progress. The EU-SPI is grounded on three pillars – basic



(a)



(b)

Figure 7. Scatter plots of gross domestic product per capita (GDPpc) and the European Social Progress Index (EU-SPI) with other EU regional indexes.

human needs, foundations of well-being and opportunities – that account for non-economic facets of social progress. The index is aimed at achieving a better understanding of disparities in social progress across European regions, as well as serving as a tool for policymaking. Although the EU-SPI was launched in 2016 and was updated in 2020, it

is currently employed for informative purposes only; and the allocation of funds within the framework of the European Cohesion Policy – one of the most important policies at the regional level – largely depends on GDPpc.

The present paper feeds into this debate with two novel contributions. First, the robustness of the 2020 release of the EU-SPI to different methodological choices in its construction is assessed. In this regard, composite indicators are very useful for summarizing, but they are sensitive to the decisions made when building them; thus, if the EU-SPI is meant to be useful for policymaking, it must be robust and provide policymakers with information that does not change significantly when some of the index-building parameters are altered. Robustness is tested in both local and global uncertainty scenarios. Results suggest that the EU-SPI is robust. In this regard, scores of social progress are somewhat sensitive to methodological choices – mainly regarding normalization – but rankings of regions are much more stable. This is important news for policymaking, since changes in the scores do not mask cross-regional disparities. And good news too for academics, who can now have confidence in the EU-SPI as a robust tool for more in-depth study of the interplay of economic and non-economic issues in shaping aggregate societal performance in European regions.

Having demonstrated the robustness of the EU-SPI, a second contribution of the paper is the comparison of social progress with income in the context of the European Cohesion Policy. The focus is on assessing whether GDPpc and the EU-SPI yield significantly different rankings of regions, thus affecting their potential eligibility for funds. Results suggest that income and social progress are fairly well correlated, but some disparities exist; for example, nearly eight out of every ten European regions classified as *less developed* according to their GDPpc would remain in the same category in terms of social progress. This figure is somewhat unsurprising as social progress and income represent complementary facets of development. Hence, the criteria used for allocating funds under European regional policies could be refined if – in addition to income – non-economic facets of development were given a higher profile. The EU-SPI is a remarkably robust indicator that offers extremely valuable information in that regard.

In all, considering the results from this research and the fact that the EU-SPI has been developed with a marked policy orientation, European policymakers are encouraged to make more effective use of this indicator. In this regard, further efforts should be made to develop criteria which judiciously combine GDPpc and the EU-SPI to determine the allocation of funds in the framework of *Agenda 2030* – whose goals have a marked beyond GDP character, and are also strongly linked to the United Nations' Sustainable Development Goals. Moreover, policies based on a combination of economic and non-economic facets of development would provide a more appropriate response to the challenges of the immediate future and, more importantly, one that better reflects people's life.

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NOTES

1. This diverse normative and moral basis can be judged as a strength of the EU-SPI, although there might be paradigms of social progress prevailing in other cultures that the index does not represent.
2. The methodology used in the two releases has remained fairly stable, although time comparisons are of limited reliability because raw indicators differ from one edition to the other. This could be seen as a weakness that hinders an assessment of the trends in social progress; however, it would also be possible to construct an index of social progress that allows for comparisons both across European regions and over time, as shown by Peiró-Palomino et al. (2023). Building such an indicator goes beyond the purpose of this research.
3. One potential weakness of the 2020 release of the EU-SPI, especially when thinking about its eventual adoption as a comprehensive tool to guide the allocation of European Cohesion Policy funds, is that some indicators rely on surveys or citizens' perceptions, and could thus be considered subjective. This could make the index politically sensitive, presenting an obstacle to its adoption.
4. This approach is also employed in the construction of the Female Achievement and Female Disadvantage indexes, but with bounds given by the maximum and minimum observed values in the sample. The European Regional Competitiveness Index, the European Quality Government Index and the Composite Weighted Index of Regional Resilience use a z-score standardization.
5. Most of the European regional indexes reviewed in section 2, including the Female Achievement and Female Disadvantage indexes, the European Regional Competitiveness Index and the European Quality Government Index, use simple arithmetic means as the main aggregation method. The Composite Weighted Index of Regional Resilience aggregates using entropy methods, whereas the

score of the European Regional Competitiveness Index is computed as a weighted average of its pillars.

6. The data were downloaded in July 2021 from the website of the European Social Progress Index (https://ec.europa.eu/regional_policy/en/information/maps/social_progress/).

7. This result regarding compensability is in line with the findings reported by Annoni et al. (2016), who, among other analyses of local sensitivity, used Monte Carlo simulations to assess the effect of the order of the generalized mean on the computation of scores of social progress and its dimensions with the 2016 release of the EU-SPI.

8. This analysis of *losers* and *winners* highlights the interesting role of the EU-SPI and its dimensions as powerful tools for setting the policy mix needed by European regions to drive their social progress. For example, in all the Northern Italian regions mentioned above, special care should be taken of environmental issues; in Bucureşti-Ilfov (RO32), in addition to stringent environmental policies, better institutional quality and the allocation of more resources to the health system are needed to spur progress in personal rights, tolerance and inclusion, and health and wellness. In short, policy responses should be always place based, determined after having carefully considered the weaknesses of each region.

9. A few indicators are included in both the EU-SPI and another regional index; for example, female participation in regional assemblies is in the Female Achievement Index. This should not be a problem because, given the large number of indicators, their weights in the aggregate indexes are small. Besides, the analysis does not seek to identify causal links between the composite indexes, but simply associations.

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