

SPES Focus on WP 3

Beyond the numbers: what composite indices reveal – and conceal – about trade-offs and synergies in sustainability transitions

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Disclaimer

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Abstract

Composite indicators measure complex processes like the sustainability transition across the pillars of the Sustainable Development Goals: Planet, Prosperity, People, Partnership, and Peace. Their popularity stems from their simplicity and comparability, but their proliferation raises concerns about ambiguity, overlap, and limited utility in addressing the systemic nature of sustainability transitions. We show that while diverse composite indices provide multiple perspectives, they often emphasize narrow dimensions, creating measurement gaps and complicating comparisons.

These measures also obscure key interactions, such as trade-offs (e.g., economic growth vs. equity), synergies, and independence among dimensions. Using Principal Component Analysis, this paper analyses six composite indices globally and in the EU27, finding that sustainability transitions involve systemic trade-offs and synergies. For instance, in the EU27, economic growth and social inclusion are negatively correlated with environmental sustainability. The authors recommend refining the selection of composite indices, improving systemic analysis, and developing interaction-sensitive indicators to capture trade-offs and synergies, ensuring more coherent and effective sustainability monitoring. Lastly, the observed variation in sustainability dynamics between global and regional samples suggests that tailored strategies are necessary.

1. Introduction

Over the past decades, the development of composite indices (CIs) and dashboards has expanded significantly to evaluate and monitor various complex dynamic processes. A query on Scopus by Greco et al. (2019) retrieved nearly 600 composite indicators in 2016, marking a nearly fivefold increase compared to 2006. Many of these indicators aim to encapsulate progress across the dimensions of the sustainability transition, frequently aligning with the five pillars of the Sustainable Development Goals (SDGs): Planet, Prosperity, People, Partnership, and Peace. Typically, scores across these dimensions are aggregated into an overall score, facilitating comparisons across countries, regions, and cities. Recent research by Gábos et al. (2023) identified 44 composite sustainability transition indicators (STIs) in use, each designed for sufficiently broad samples of countries.

This growing prevalence underscores the critical role of STIs in measuring, monitoring, and comparing nations' progress toward sustainability. However, while these indices provide a convenient numerical representation of sustainability efforts, they also obscure important complexities. As the title of this paper suggests, we move beyond the numbers to examine what these indices reveal—and conceal—about sustainability transitions. In particular, two key challenges must be addressed to ensure their relevance.

First, the abundance and popularity of STIs reflect not only their communicative simplicity but also the multidimensionality of sustainability itself. The variation in scope and aggregation methods among STIs (Gábos et al., 2023) illustrates diverse, sometimes conflicting, interpretations of what sustainability entails, and first of all the opposition between weak and strong versions). This diversity can create ambiguity about the requirements for a successful transition, necessitating a systematic evaluation of what each STI measures. Specifically, determining whether these indicators collectively provide a comprehensive picture of sustainability or merely fragmented insights is essential.

Second, STIs inherently represent aggregate achievements, which limits their capacity to capture interactions—both synergies and trade-offs—between different dimensions of the transition. Sustainability is widely recognized as a systemic process (IPCC, 1992, 2023; Grin et al., 2010; Köhler et al., 2019; Moallemi et al., 2022), characterized by interdependencies between its various components. Progress in one dimension often influences, and is influenced by, others. For instance, increases in carbon taxes have demonstrated how decarbonization efforts can inadvertently exacerbate inequalities for individuals reliant on private transportation or living in remote areas that may eventually backfire against transition policies. While STIs may imply such interactions through aggregated outcomes, they are not designed to reveal them more explicitly.

This paper aims to address these two challenges. First, we examine a diverse set of STIs to determine whether they reflect correlated or independent aggregate perspectives on sustainable development. Using the SPES conceptual framework (Biggeri et al., 2023), which aligns with the SDG pillars, we systematically analyze the capacity of 11 STIs identified by Gábos et al. (2023) to comprehensively represent all these pillars of sustainability transitions. Our findings confirm Gábos et al. (2023)'s observation that each STI offers a partial perspective, emphasizing the need for integrated analysis to achieve a fuller understanding of the transition. Most STIs focus on specific combinations of the SDG/SPES pillars rather than providing holistic coverage. Analyzing the linear correlations among the eleven STIs in our study, we find that only about half are positive and significant at the 5% level—contrary to the expectation that all indicators would capture the same overall progress toward the SDGs. Even more striking, 7% of the correlations are negative and significant.

Next, we leverage the diversity and complementarity of the STIs analyzed by Gábos et al. (2023) to investigate cross-dimensional correlations. Specifically, we focus on our selection of six STIs addressing one-to-one interactions between the Planet, Prosperity, People, and Partnership pillars. These STIs collectively encompass all transition dimensions and bilateral interfaces. By using multidimensional statistical methods for analyzing their correlations, we identify patterns of synergy, trade-off, or independence between dimensions, offering insights into how progress in one area supports or hinders advancements in others.

In our global analysis of 164 countries, we found that progress on the Prosperity, People, and Partnership pillars was largely independent of advancements in the Planet pillar, reflecting diverse pathways to sustainability. However, regional patterns revealed more nuanced dynamics. In lower-income countries with limited engagement in sustainability transitions, synergies between these dimensions were more pronounced. Conversely, in higher-income nations with more advanced sustainability efforts, trade-offs became apparent, particularly between environmental sustainability and economic or social objectives.

Within the EU27, our analysis identified a strong synergy between Prosperity, social equity, and democratic governance. However, this cluster showed a negative correlation with environmental sustainability, highlighting a trade-off between sustainable economic growth and inclusive social development. Progress on the Planet-People interface, representing the just transition, remained largely independent of other dimensions, mirroring global trends.

There is broad consensus on the need to strengthen sustainability monitoring and it is often advocated that future efforts should prioritize refining composite indicators (CIs). Our findings emphasize that sustainability transitions are inherently systemic, requiring a holistic approach to interdimensional interactions to avoid fragmented or counterproductive strategies. This has two main policy consequences. While CIs remain valuable for tracking progress, they must be applied with caution, as their current design struggles to capture complex interdependencies. Second, targeted statistical analyses can help bridge these gaps: the proliferation of sustainability composite indicators (STIs) presents an opportunity to improve the monitoring of interdependencies, leveraging both their widespread use and inherent limitations to advance sustainability analysis.

The rest of this paper is structured as follows: Section 2 reviews the potential and challenges of using STIs to monitor sustainability transitions. Section 3 evaluates the performance of sustainability STIs in covering various transition dimensions and addresses ambiguity issues. Section 4 outlines our methodology for mapping interdimensional relationships across six STIs. Sections 5 and 6 present results for global and EU27 samples, respectively, while Section 7 discusses policy implications and concludes.



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