Sensitivity-based Weighting Method for Composite Indicators: Statistical Framework, Estimation Procedure, and Application

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Abstract

Composite indicators are widely recognized as an effective tool for solving problems of multidimensional measurement. The proliferation of related theoretical frameworks and methodologies has been accompanied by a growing debate surrounding the determination of weights. This paper presents a distribution-based method that assists developers in achieving a set of sensitivity-based weights, where the magnitude of each weight aligns with the proportion of output variance contributed by the corresponding input. To facilitate the weighting procedure, two supporting algorithms are introduced, including the regression-based estimation and the coarse estimation techniques. These algorithms are tested in two numerical simulation cases. The findings show that the paramount factor affecting the accuracy and consistency of estimates lies in the sample size, and the coarsening technique exhibits superiority in performance when dealing with inputs from various distributions. A composite indicator has been devised to measure well-being in European regions, serving as an intermediary mechanism to juxtapose the proposed weighting method against other approaches. Through a novel technique called pairwise ranking stability analysis, the sensitivity-based weighting method reveals its superior robustness in benchmarking endeavors compared to the alternative approach based on principal component analysis.

Keywords: composite indicator, sensitivity analysis, weight optimization.