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"Shattering Break Barriers: Inferential Theory for Group Factor Models Subject to Disruptive Breaks"

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Abstract: The homogeneous group structure in factor analysis is widely recognized for streamlining the clustering of high-dimensional time series, a property that directly enhances estimation precision. This study focuses on a grouped factor model where two critical components---latent group memberships and factor loadings---experience abrupt structural changes often triggered by real-world disruptions, including technological advancements, economic or financial crises, and policy adjustments. A critical finding of this research is that neglecting structural instability leads to three severe inferential issues: inconsistent recovery of the factor space, overestimation of the number of factors, and overestimation of the number of groups. To address these challenges and ``shatter the break barriers,'' we propose a four-step procedure tailored to achieve consistent and efficient estimation. We first identify a ``pseudo group structure'' and estimate corresponding pseudo factors within a pseudo linear factor model---one that temporarily sets aside structural breaks. We next detect structural break points using shrinkage techniques applied to the pseudo factor regression. Finally, we sequentially merge pseudo groups in an iterative manner, halting only when no further improvement in model fit is achieved as evaluated using an information criterion. Theoretical properties of the proposed procedure, including consistency in break point estimation, accurate recovery of the true group structure, and reliable inference for the factor space, are established. These results are corroborated with both Monte Carlo simulations and an application to studying U.S. macroeconomic datasets that demonstrate the superior performance of our procedure over alternative approaches in high-dimensional time series analysis.