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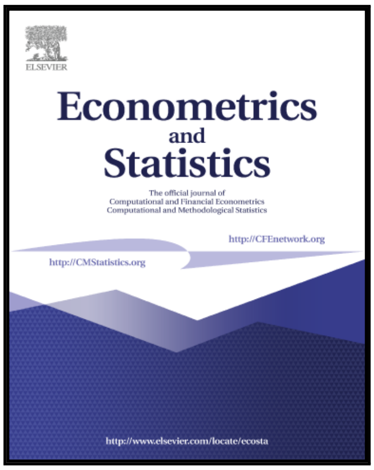

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Preliminary Test Estimation for Multi-sample Principal Components

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Abstract

Point estimation is considered in a multi-sample principal components setup, in a situation where it is suspected that the hypothesis of common principal components (CPC) holds. Preliminary test estimators of the various principal eigenvectors are proposed. Their asymptotic distributions are derived (i) under the CPC hypothesis, (ii) under sequences of hypotheses that are contiguous to the CPC hypothesis, and (iii) away from the CPC hypothesis. A Monte-Carlo study shows that the proposed estimators perform well, particularly so in the Gaussian case.

Keywords: Preliminary test estimation, Common Principal Components

1. Introduction

Principal Component Analysis (PCA) is arguably one of the most popular multivariate methods. In this paper, we consider PCA in a multi-sample context. Consider $m(> 1)$ mutually independent samples of p-vectors $\mathbf{X}_{i1}, \ldots, \mathbf{X}_{in_i}$, $i = 1, \ldots, m$, with respective sample sizes $n_1, \ldots, n_m$, such that for any i, the $\mathbf{X}_{ij}$'s form a random sample from a distribution with mean $\boldsymbol{\theta}_i$ and covariance matrix $\boldsymbol{\Sigma}_i$. In the ith population, the rth principal component scores are

$$(\boldsymbol{\beta}_i^{(r)})'\mathbf{X}_{i1}, \ldots, (\boldsymbol{\beta}_i^{(r)})'\mathbf{X}_{in_i}, \tag{1.1}$$

where $\boldsymbol{\beta}_i^{(r)}$ is the unit eigenvector associated with the rth largest eigenvalue of $\boldsymbol{\Sigma}_i$. In other words, $\boldsymbol{\beta}_i^{(r)}$ is the rth column vector in the matrix $\boldsymbol{\beta}_i$ from the factorization $\boldsymbol{\Sigma}_i = \boldsymbol{\beta}_i \boldsymbol{\Lambda}_i \boldsymbol{\beta}_i'$, where $\boldsymbol{\beta}_i \in \mathcal{SO}_p := \{\mathbf{O} \in \mathbb{R}^{p\times p} : \det(\mathbf{O}) = 1 \text{ and } \mathbf{O}^{-1} = \mathbf{O}\}$ and $\boldsymbol{\Lambda}_i := \mathrm{diag}(\lambda_{i1}, \ldots, \lambda_{ip})$ (with $\lambda_{i1} \geq \lambda_{i2} \geq \ldots \geq \lambda_{ip}$).

If no extra assumptions are adopted, then m eigenvectors matrices, namely $\boldsymbol{\beta}_1, \ldots, \boldsymbol{\beta}_m$, are to be estimated, each on the basis of the observations from the corresponding population,

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