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A new class of efficient and debiased two-step shrinkage estimators: method and application

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ABSTRACT

This paper introduces a new class of efficient and debiased two-step shrinkage estimators for a linear regression model in the presence of multicollinearity. We derive the proposed estimators' mean square error and define the necessary and sufficient conditions for superiority over the existing estimators. In addition, we develop an algorithm for selecting the shrinkage parameters for the proposed estimators. The comparison of the new estimators versus the traditional ordinary least squares, ridge regression, Liu, and the two-parameter estimators is done by a matrix mean square error criterion. The Monte Carlo simulation results show the superiority of the proposed estimators under certain conditions. In the presence of high but imperfect multicollinearity, the two-step shrinkage estimators' performance is relatively better. Finally, two real-world chemical data are analyzed to demonstrate the advantages and the empirical relevance of our newly proposed estimators. It is shown that the standard errors and the estimated mean square error decrease substantially for the proposed estimator. Hence, the precision of the estimated parameters is increased, which of course is one of the main objectives of the practitioners.

1. Introduction

To describe the problem, we consider the following classical linear regression model (LRM):

$$Y = X\beta + \varepsilon, \tag{1}$$

where Y is a $(n \times 1)$ vector of observations on the response variable, X is a $(n \times p)$ full ranked design matrix consisting of the explanatory variables, β is a $(p \times 1)$ column vector of unknown regression coefficients and ε is a $(n \times 1)$ vector of random errors assumed to be normally distributed with $E(\varepsilon) = 0$ and $E(\varepsilon\varepsilon^T) = \sigma^2 I_n$ where I_n is a $(n \times n)$ identity matrix. The ordinary least square estimator (OLSE) of the unknown parameter vector β is:

$$\hat{\beta}_{OLS} = (X^T X)^{-1} X^T Y. \tag{2}$$

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