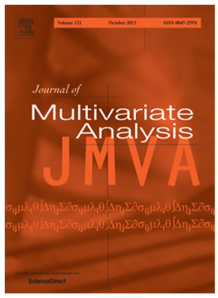
Accepted Manuscript



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PII: S0047-259X(18)30028-9
DOI: https://doi.org/10.1016/j.jmva.2018.05.002
Reference: YJMVA 4361

To appear in: *Journal of Multivariate Analysis*

Received date : 15 January 2018

Robust inference for seemingly unrelated regression models

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Abstract

Seemingly unrelated regression models generalize linear regression models by considering multiple regression equations that are linked by contemporaneously correlated disturbances. Robust inference for seemingly unrelated regression models is considered. MM-estimators are introduced to obtain estimators that have both a high breakdown point and a high normal efficiency. A fast and robust bootstrap procedure is developed to obtain robust inference for these estimators. Confidence intervals for the model parameters as well as hypothesis tests for linear restrictions of the regression coefficients in seemingly unrelated regression models are constructed. Moreover, in order to evaluate the need for a seemingly unrelated regression model, a robust procedure is proposed to test for the presence of correlation among the disturbances. The performance of the fast and robust bootstrap inference is evaluated empirically in simulation studies and illustrated on real data.

Keywords: Diagonality test, Fast and robust bootstrap, MM-estimator, Robust testing

1. Introduction

Many scientists have investigated statistical problems involving multiple linear regression equations. Unconsidered factors in these equations can lead to highly correlated disturbances. In such cases, estimating the regression parameters equation-by-equation by, e.g., least squares is not likely to yield efficient estimates. Therefore, seemingly unrelated regression (SUR) models have been developed. SUR models take the underlying covariance structure of the error terms across equations into account. Applications in econometrics and related fields include demand and supply models [13, 18], capital asset pricing models [9, 20], chain ladder models [11, 37], vector autoregressive models [33], household consumption and expenditure models [15, 16], environmental sciences [19, 35], natural sciences [5, 7], and many more.

A SUR model, introduced by Zellner [36], consists of $m > 1$ dependent linear regression equations, also called blocks. Denote the jth block in matrix form by $y_j = X_j\beta_j + \varepsilon_j$, where $y_j = (y_{1j}, \ldots, y_{nj})^\top$ contains the n observed values of the response variable and X_j is an $n \times p_j$ matrix containing the values of p_j input variables. Note that the number of predictors does not need to be the same for all blocks. The vector $\beta_j = (\beta_{1j}, \ldots, \beta_{p_j j})^\top$ contains the unknown regression coefficients for the jth block and $\varepsilon_j = (\varepsilon_{1j}, \ldots, \varepsilon_{nj})^\top$ constitutes its error term. The error term ε_j is assumed to have $\mathrm{E}(\varepsilon_j) = 0$ and $\mathrm{cov}(\varepsilon_j) = \sigma_{jj} I_n$, where σ_{jj} is the unknown variance of the errors in the jth block, and I_n represents the identity matrix of size n. In the SUR model blocks are connected by the assumption of contemporaneous correlation. That is, the ith element of the error term of block j may be correlated with the ith element of the error term of block k. With i and ℓ observation numbers, and j and k block numbers, the covariance structure of the disturbances can be summarized as

$$\begin{aligned}
&\mathrm{E}(\varepsilon_{ij}\varepsilon_{ik}) = \sigma_{jk}, \quad i \in \{1, \ldots, n\}, j, k \in \{1, \ldots, m\};\\
&\mathrm{E}(\varepsilon_{ij}\varepsilon_{\ell j}) = 0, \quad i \neq \ell;\\
&\mathrm{E}(\varepsilon_{ij}\varepsilon_{\ell k}) = 0, \quad j \neq k \text{ and } i \neq \ell.
\end{aligned}$$

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[1]Declarations of interest: none.