MCMC Estimation of Restricted Covariance Matrices

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This article is motivated by the difficulty of applying standard simulation techniques when identification constraints or theoretical considerations induce covariance restrictions in multivariate models. To deal with this difficulty, we build upon a decomposition of positive definite matrices and show that it leads to straightforward Markov chain Monte Carlo samplers for restricted covariance matrices. We introduce the approach by reviewing results for multivariate Gaussian models without restrictions, where standard conjugate priors on the elements of the decomposition induce the usual Wishart distribution on the precision matrix and vice versa. The unrestricted case provides guidance for constructing efficient Metropolis-Hastings and accept-reject Metropolis-Hastings samplers in more complex settings, and we describe in detail how simulation can be performed under several important constraints. The proposed approach is illustrated in a simulation study and two applications in economics. Supplemental materials for this article (appendices, data, and computer code) are available online.

Key Words: Accept-reject Metropolis-Hastings algorithm; Bayesian estimation; Cholesky decomposition; Correlation matrix; Markov chain Monte Carlo; Metropolis-Hastings algorithm; Multinomial probit; Multivariate probit; Unconstrained parameterization; Wishart distribution.

Supplementary Materials

1. Data Sets

`Readme1545.txt` Description of the data for the MVP application in Section 5.1.

`X1545.dat` Covariates for the MVP application in Section 5.1.

`Y1545.dat` Responses for the MVP application in Section 5.1.

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`Xtravel6.txt` Covariates for the MNP application in Section 5.2.

`ytravel6.txt` Responses for the MNP application in Section 5.2.

2. Computer Code

`ex1.m` Matlab code for illustration 1 in Section 4.1.

`ex2.m` Matlab code for illustration 2 in Section 4.1.

`ex3.m` Matlab code for illustration 3 in Section 4.1.

`MNPexample.m` Matlab code for the MNP application in Section 5.2.

`lmvnpdf.m` Matlab function called by MNPexample.m.

`tnormrnd.m` Matlab function called by MNPexample.m.

`MVPexampleJCGS.s` Gauss code for the examples in Section 4.2 and the MVP application in Section 5.1.

3. Supplementary Documents

`Appendix.pdf` This document contains Appendices A and B which were referenced in the article.