

Characterizing interdependencies of the vector ARMA series: theory and application

Taro Takimoto and Yuzo Hosoya

Abstract

Focusing on the stationary multivariate ARMA processes, the paper proposes an approach to quantitatively characterize in the frequency domain the strength of one-way effects and reciprocity between a pair of series in the presence of a third series, suggesting a unified statistical method of estimation and testing for the partial measures of interdependence.

To deal with the third series presence problem, Hosoya (2001) characterized, in the frequency domain, the effect which one series produces onto another and the reciprocal effect between the two in the presence of a third series, introducing the idea of how to eliminate from the pair of the subject-matter series the one-way effect of third series, but the paper did not go into the problems of how to arrive at numerically such a factor or how to conduct statistical inference. The new aspect of the present paper is the introduction of a numerically executable procedure based on the canonical factorization algorithm of Hosoya-Takimoto (2010) for multivariate MA spectral matrices and a revised version of the three-step Whittle-likelihood maximization for the model parameter estimation. Furthermore, the paper proposes Monte Carlo Wald tests for the purpose of testing and constructing interval-estimates of those measures.

We show in the paper a part of the ongoing extensive simulation study to evaluate finite sample performance of the proposed estimation and testing procedures. The numerical results suggest, on the whole, that the third-step estimates do not improve notably the second-step estimates in respect of bias and sampling variation for small-sample data. For empirical illustration, the paper investigates interdependent relationships between the term spread and the growth of GDP based on a set of U.S. time-series data, comparing the estimation and testing results for a variety of third-series presence as well as with the unconditional simple result. The result is also compared with the existing literature.

References

- Hosoya, Y. (2001) "Elimination of third-series effect and defining partial measures of causality", *Journal of Time Series Analysis*, vol.22, pp.537–554.
- Hosoya, T. and Takimoto, T. (2010) "A numerical method for factorizing the rational spectral density matrix", *Journal of Time Series Analysis*, vol.31, pp.229–240.
- Takimoto, T. and Hosoya, Y. (2004) "A three-step procedure for estimating and testing cointegrated ARMAX models", *The Japanese Economic Review*, vol.55, pp.418–450.