Sparse Identification and Estimation of High-Dimensional Vector AutoRegressive Moving Averages

The Vector AutoRegressive Moving Average (VARMA) model is fundamental to the study of multivariate time series. However, estimation becomes challenging in even relatively low-dimensional VARMA models.

With growing interest in the simultaneous modeling of large numbers of marginal time series, many authors have abandoned the VARMA model in favor of the Vector AutoRegressive (VAR) model, which is seen as a simpler alternative, both in theory and practice, in this high-dimensional context. However, even very simple VARMA models can be very complicated to represent using only VAR modeling. In this paper, we develop a new approach to VARMA identification and propose a two-phase method for estimation. Our identification and estimation strategies are linked in their use of sparsity-inducing convex regularizers, which favor VARMA models that have only a small number of nonzero parameters.

We establish sufficient conditions for consistency of sparse infinite-order VAR estimates in high dimensions, a key ingredient for our two-phase sparse VARMA estimation strategy. The proposed framework has good estimation and forecast accuracy under numerous simulation settings. We illustrate the forecast performance of the sparse VARMA models for several application domains, including macro-economic forecasting, demand forecasting, and volatility forecasting. The proposed sparse VARMA estimator gives parsimonious forecast models that lead to important gains in relative forecast accuracy. Our preprint is available here: https://arxiv.org/abs/1707.09208