Regularized estimation and testing for High-Dimensional Multi-Block Vector Autoregressive Models

George Michailidis

University of Florida

Abstract

Dynamical systems comprising of multiple components originate in many scientific areas. A pertinent example is the interactions between financial assets and macroeconomic indicators, which has been studied at *an aggregate level* in the macroeconomics literature. A key shortcoming of this approach is that it ignores potential influences from other related components (e.g. Gross Domestic Product) that may exert influence on the system's dynamics and structure and thus produces incorrect results. To mitigate this issue, we consider a multi-block linear dynamic system with Granger-causal ordering between blocks, wherein the blocks temporal dynamics are described by vector autoregressive processes and are influenced by blocks higher in the system hierarchy. We obtain the maximum likelihood estimator for the posited model for Gaussian data in the high-dimensional setting with appropriate regularization schemes. To optimize the non-convex likelihood function, we develop an iterative algorithm with convergence guarantees. We establish theoretical properties of the maximum likelihood estimates, leveraging the decomposability of the regularizers and a careful analysis of the iterates of the proposed algorithm. Finally, we develop testing procedures for the null hypothesis of whether a block "Granger-causes" another block of variables. The performance of the model and the testing procedures are evaluated on synthetic data, and illustrated on a data set involving log-returns of the US S&P100 component stocks and key macroeconomic variables for the 2001–16 period.