The University of Chicago
Department of Statistics

Ph.D. Seminar

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Statistical Inference for Multivariate Nonlinear Time Series

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ABSTRACT

The conditional standard deviation, or volatility, of asset returns evolves over time; financial volatilities move together over time across assets and markets. Efficient estimation of a time-varying multivariate volatility matrix requires conditioning on the joint information from all components of the historical return vector. For even a handful of assets, the curse of dimensionality quickly makes estimation of most multivariate models impractical.

To specify flexible dynamics for the evolution of a high dimensional volatility matrix, simple, measurable transformations of univariate volatility models may be empirically adequate, and provide a significant simplification of the general problem. A linear transformation is sufficient if the specified univariate models are assumed to be conditionally uncorrelated given the information from the joint historical return vector. Herein, we consider the stronger assumption of mutually independent components. Latent independent components are estimated via nonlinear decorrelation of robust, continuously differentiable transformations of the innovation vector, which are estimated to be as independent as possible for a particular sample. Our estimation procedure is shown to be consistent and is computationally practical, with a simple analytical gradient, for very high dimensional vector stochastic processes. Distribution theory is derived from cross moment matching, as in generalized estimating equations, or similarly, the generalized method of moments.

Monte Carlo simulation studies are used to demonstrate the asymptotic results of the proposed method under various parameterizations. Extensive data analysis is also presented to evaluate our method's empirical performance. Standard multivariate diagnostic checking establishes the model's in-sample empirical adequacy. A series of portfolio optimization problems shows that the proposed model outperforms several competing models in out-of-sample evaluation.

Our multivariate conditional heteroscedastic model is simple to estimate. The high dimensional estimation problem is reduced to a set of disjoint univariate models. Our approach allows exact or stochastic parameterizations as well as flexible conditional distributions. It is easily extended to allow asymmetry in the respective volatility series. The implied correlation matrix evolves over time without explicit modeling. Additionally, the estimated volatility matrix series, and its forecasts, are positive-definite at every time point.

Information about building access for persons with disabilities may be obtained in advance by calling Jewanna Carver at 773.834-5169 or by email (carver@galton.uchicago.edu).