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TIME-VARYING MIXTURE COPULA MODELS WITH COPULA SELECTION

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Abstract: Modeling the joint tails of multiple financial time series has many important implications for risk management. Classical models for dependence often encounter a lack of fit in the joint tails, calling for additional flexibility. This paper introduces a new semiparametric time-varying mixture copula model, in which both the weights and the dependence parameters are deterministic and unspecified functions of time. We propose using penalized time-varying mixture copula models with group smoothly clipped absolute deviation penalty functions to perform the estimation and the copula selection simultaneously. Monte Carlo simulation results suggest that the shrinkage estimation procedure performs well in selecting and estimating both constant and time-varying mixture copula models. Using the proposed model and method, we analyze the evolution of the dependence between four international stock markets, finding substantial changes in the levels and patterns of the dependence, particularly around crisis periods.

Key words and phrases: Copula selection, EM algorithm, mixture copula, SCAD, time-varying distribution.

1. Introduction

Copulas have received considerable attention because they offer great flexibility when modeling multivariate distributions and when characterizing nonlinear dependence and tail dependency. A copula function glues various types of marginal distributions, including symmetric, skewed, and heavy-tailed distributions, into a multivariate distribution, and by Sklar (1959) theorem, this is always possible. The variety of dependence patterns is important for financial and macroeconomic time series, leading to applications such as volatility clustering (Ning, Xu and Wirjanto (2015)), real-time density forecasting (Smith and Vahey (2016)), stock returns modeling under nonstationarity (Wollschläger and Schäfer (2016)), systemic risk (Mensi et al. (2017)), and so on.

Among the applications of copula models, studying the co-movements of

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