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Inference on the tail process with application to financial time series modelling

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Abstract

To draw inference on serial extremal dependence within heavy-tailed Markov chains, Drees, Segers and Warchoł [Extremes (2015) 18, 369–402] proposed nonparametric estimators of the spectral tail process. The methodology can be extended to the more general setting of a stationary, regularly varying time series. The large-sample distribution of the estimators is derived via empirical process theory for cluster functionals. The finite-sample performance of these estimators is evaluated via Monte Carlo simulations. Moreover, two different bootstrap schemes are employed which yield confidence intervals for the pre-asymptotic spectral tail process: the stationary bootstrap and the multiplier block bootstrap. The estimators are applied to stock price data to study the persistence of positive and negative shocks.

Keywords: Financial time series; Heavy–tails; Multiplier block bootstrap; Regular variation; Shock persistence; Stationary time series; Tail process.

1 Introduction

The typical modelling paradigm for a time series often starts by choosing a flexible class of models that captures salient features present in the data. Of course, *features* depends on the type of characteristics one is looking for. For a financial time series consisting of say log-returns of some asset, the key features, often referred to as *stylized facts*, include heavy-tailed marginal distributions and serially uncorrelated but dependent data. These characteristics are readily detected using standard diagnostics such as qq-plots of the marginal distribution and plots of the sample autocorrelation function (ACF) of the data and the squares of the data. The GARCH process (and its variants) as well as the stochastic volatility (SV) process driven by heavy-tailed noise exhibit these attributes and often serve as a starting point for building a model. More recently, considerable attention has been directed towards studying the extremal behavior of both financial and environmental time series, especially as it relates to estimating risk factors. Extremes for such time series can occur in clusters and getting a handle on the nature of clusters both in terms of size and frequency of occurrence is important for evaluating various risk measures. Ultimately, one wants to choose models that adequately describe various extremal dependence features observed