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The extremogram: a correlogram for extreme events

Multivariate regular variation is often used as a building block for modeling heavy-tailed phenomena. Interestingly, many time series models, such as GARCH and stochastic volatility (SV) models that are commonly used for modeling financial time series, have regularly- varying finite-dimensional distributions. While GARCH and SV models share many of the same properties--both are martingale differences and exhibit heavy tails and volatility clustering, it turns out that the extremal behavior is quite different. Unlike a SV process, extremes cluster for a GARCH process.

To measure extremal dependence, we define an analog of the autocorrelation function called the extremogram, which only depends on the extreme values in the sequence. We propose a natural estimator for the extremogram and study its asymptotic properties under alpha-mixing. We calculate the extremogram for various examples and consider spectral analysis related to the extremogram. Ultimately, we hope the extremogram can be useful for describing dependence in the extremes and for model building when it is important capture important features of the extremes.

The use of the extremogram in applications in both finance and environmental contexts will be illustrated. Currently, bootstrapping methods are being adapted to the extremogram in order to construct more meaningful and useful inference procedures. These techniques, as well as permutation procedures, will be demonstrated on several data sets.

(This is joint work with Thomas Mikosch and Ivor Cribben.)