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Autoregressive conditional tail behavior and results on Government bond yield spreads

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Abstract

Previous evidence in empirical finance indicates the potential usefulness of modeling time variation particularly in the tails of speculative return distributions. Based on results from extreme value theory, the present paper proposes a fixed changepoint Pareto-type autoregressive conditional tail (ARCT) model. Regression-based parameter estimation of the unobservable time-varying tail index is carried out via classical Kalman filtering. A model application highlights the tail index dynamics for daily changes in Government bond yield spreads between the U.S. Dollar and the Euro zone.

JEL classification: C16; C22; C53; G10
Keywords: Tail index; Pareto model; Autoregressive conditional tail; Extreme financial risk; Spread risk

1. Introduction

The forecasting of large price movements in economics and finance is surely a difficult, while at the same time, central issue in financial management. This explains why the prediction of risk—frequently associated with the prediction of return volatility—has been the subject of a vast number of papers within the empirical finance literature. Despite huge advances in the area during the last two decades—including the modeling of generalized autoregressive conditional heteroskedasticity (GARCH)—several authors recently put some doubt on the applicability of available

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volatility models for risk management and for extreme price movements in particular. As such, Shephard (1996, p. 21) notes that "GARCH models cannot deal with the extremely large movements in financial markets, even though they are good models of changing variance." Danielsson and Morimoto (2000, p. 15) suggest that "the wild swings observed in the GARCH VaR [Value-at-Risk] predictions are more of an artifact of the GARCH model rather than the underlying data." Engle (2000, p. 2) notes "it is not clear whether the tails have the same dynamic behavior as the rest of the distribution as would be assumed by GARCH style models." Considering higher conditional moments, Rockinger and Jondeau (2002, p. 140) conclude that it seems that "there is little evidence that skewness and kurtosis are dependent on past returns. One possible reason for this finding is that these moments are driven by extreme realizations that occur only infrequently." At the same time, empirical findings suggest the modeling of time variation in the conditional tails of return distributions. Quintos, Fan, and Phillips (2001, p. 634) summarize earlier work by noting that "there is a consensus from past empirical research that the tail behavior of certain financial series are time varying." Along with the authors mentioned above, Christoffersen and Diebold (2000, p. 21) point out that "it seems [...] that all models miss the really big movements [...], and ultimately the really big movements are the most important for risk management. This suggests the desirability of directly modeling the extreme tails of return densities [...]."

Given the above statements among others, the present paper aims at going in the indicated direction by proposing a model based on autoregressive conditional tail (ARCT) behavior. The route taken follows the one directed by extreme value theory, i.e., focus is put on the tail of the conditional return distribution function. Instead of modeling conditional return variance, taking volatility clustering into account or modeling conditional quantiles as was done previously[1], we suggest modeling a time-varying conditional tail index. The so-called tail index is known to be a key parameter which characterizes tail behavior in extreme value theory. As supported by theoretical arguments and empirical evidence, the assumption is made that the time-varying distributions are fat tailed throughout; that is, they all belong to the maximum domain of attraction of the Fréchet-type extreme value distribution. Consequently, a Pareto-type ARCT model results. Introducing fixed changepoints which are evenly spread through time, model estimation is based on a regression equation which is derived from the empirical distribution function. Although other estimation techniques found wider application in extreme value statistics, the static regression approach is known for long; recently, related statistical results were outlined, for example, in Datta and McCormick (1998). Van den Goorbergh (1999) provides a financial application. We choose the approach for three reasons. First, it follows immediately from the

[1] For conditional variance modeling, see, for example, Hsieh (1993), Hull and White (1998) and McNeil and Frey (2000). Wagner and Marsh (2004) propose an unconditional approach which takes GARCH-type volatility clustering into account. Time-varying return quantiles are derived by Engle and Manganelli (1999) who model autoregressive conditional VaR-quantiles and by Chernozhukov and Umantsev (2001) who apply quantile regression methods.