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Chun-Kai Huang, Delia North, Temesgen Zewotir

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Exchangeability, Extreme Returns and Value-at-Risk Forecasts

Chun-Kai Huang (University of Cape Town & University of KwaZulu-Natal)

Delia North (University of KwaZulu-Natal)

Temesgen Zewotir (University of KwaZulu-Natal)

Abstract

In this paper, we propose a new approach to extreme value modelling for the forecasting of Value-at-Risk (VaR). In particular, the block maxima and the peaks-over-threshold methods are generalised to exchangeable random sequences. This caters for the dependencies, such as serial autocorrelation, of financial returns observed empirically. In addition, this approach allows for parameter variations within each VaR estimation window. Empirical prior distributions of the extreme value parameters are attained by using resampling procedures. We compare the results of our VaR forecasts to that of the unconditional extreme value theory (EVT) approach and the conditional GARCH-EVT model for robust conclusions.

Keywords: value-at-risk; extreme value; exchangeability; block maxima; peaks-over-threshold.

JEL Classification: C13, C51, G12, G17.

1. Introduction

Value-at-risk (VaR) is a commonly used benchmark for quantifying financial risk and is intended to measure the maximum possible loss of a portfolio over a specified time horizon. VaR has also prevailed as an important and widely used risk measure since the occurrence of numerous noteworthy risk management failures in the early 1990's. Most computations of VaR critically depend on an underlying distributional assumption and focus mainly on the tail behaviours (Jorion, 2006). Consequently, the selection of an appropriate distribution, or a related methodology, to accurately reflect the behaviour of financial returns has become a vital topic of research over the past two decades.

It has been well documented that empirical distribution of financial returns contradicts the classical Gaussian assumptions. For instance, Fama (1965) showed that extreme movements in financial returns emerge more frequently than estimated by Gaussian models (i.e., they exhibits heavy-tails). Aas and Haff (2006) also showed that asset returns data often exhibits skewness in distribution, with dissimilar tail behaviours. Further stylised facts, such as volatility clustering and long range dependency, are also discussed by Tsay (2010). Hence, the conjecture of a potential distribution for financial returns must be able to capture such properties in order to obtain accurate VaR estimates.

Extreme value theory (EVT) has emerged as a suitable candidate for modelling VaR as it can account for both heavy-tails and skewness. Consequently, it has been extensively applied to model tail probabilities in financial returns. Koedijk *et al.* (1990) was among the first to apply EVT to the financial framework, by using the methods to study fat-tail behaviours in foreign exchange rate returns. Shortly thereafter, Jansen and de Vries (1991) used EVT to generate robust probabilities for large returns on share prices. Ho *et al.*