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Guangyu Mao, Zhengjun Zhang

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Stochastic Tail Index Model for High Frequency Financial Data with Bayesian Analysis

Guangyu Mao*
School of Economics and Management, Beijing Jiaotong University, China

Zhengjun Zhang†
Department of Statistics, University of Wisconsin-Madison, USA

Abstract: This paper proposes a new dynamic model called *Stochastic Tail Index* (STI) model to analyze time-varying tail index for financial asset using high frequency return data. Bayesian tools are developed to estimate the model, make related inferences, and perform model selection. To construct efficient posterior sampler for the STI model by an approximation approach, a new algorithm called ALSO (Auxiliary Least Squares Optimization) is introduced, which can quickly make sufficient approximation to a given random variable using Gaussian mixture variables. The posterior sampler takes advantages of the BFGS optimization method to tailor the proposal densities in Metropolis-Hastings chains, and is computationally faster than the existing samplers in literature. Simulation shows that the proposed posterior sampler works well for the STI model. To illustrate the use of the STI model in the real world, we analyze two real high frequency data sets associated with two markets. It is found that the estimated daily tail indexes generally follow a time-varying pattern and tend to fall when large negative events occur. Besides, they significantly drop below 2 during some periods, which implies that the variances of the return distributions during those periods may be infinite, and hence any variance-based risk management for the two markets may be questionable.

Keywords: Beyesian Statistics, Extreme Values, High Frequency, State Space Model, Tail Index.

JEL Codes: C11, C22, G32.

1 Introduction

Over the past two decades, extreme financial events have repeatedly shown their dramatic and negative effects on global economy, which include the Asian financial crisis of 1997–1998, the bursting of dot-com bubble in 2001, the global financial crisis of 2007–2009 triggered by US subprime mortgage crisis, and the European sovereign debt crisis in 2010, to name a few.

*Email: *gymao@bjtu.edu.cn.*
†Corresponding author. Email: *zjz@stat.wisc.edu.*