Kernel Weighted Average Estimation for Calibrating a Heavy-Tailed Financial Model

Andrews T. Anum[‡], John Koomson[†], Michael Pokojovy[*,†,‡] and Su Chen[§]

[*]Department of Mathematical Sciences
[†]Data Science Program
[‡]Computational Science Program
The University of Texas at El Paso, El Paso, TX

[§]Department of Biostatistics
University of Nebraska Medical Center, Omaha, NE

Abstract

A wide variety of location and scale estimators have been developed for light-tailed distributions such as the Gaussian one. Despite the ubiquitousness and importance of heavy-tailed distributions in real-life applications in business, finance, cybersecurity and other arenas, estimation and inference in the presence of thick tails have received much less attention in the statistical literature. For heavy-tailed populations, the first and/or second moments may fail to exist so that usual sample moments cannot be used to estimate location and scatter parameters. In contrast, Kernel Weighted Average (KWA) estimation can effectively be applied in this situation. Like other kernel procedures, KWA estimators rely on the choice of a kernel function and a bandwidth. Using KWA estimation, we propose a new procedure to fit a geometric random walk model with Student's t_ν log-increments with unknown degrees of freedom $\nu \geq 1$. The procedure involves a grid search over a set of candidate ν values based on maximizing the p-value from the well-known Cramér-von Mises test. Unlike many existing methodologies, our approach is data-driven and exhibits excellent statistical performance. To llustrate our proposed methodology, we apply it to three real-world financial datasets containing daily closing prices of AMC Entertainment Holdings, Inc. (AMC), GameStop Corp. (GME) and Meta Platforms, Inc. (FB) stocks. Log-increments for all of these three stocks are empirically shown to exhibit super-Gaussian tails suggesting Student's t_ν distribution is a more adequate model.

Keywords: Kernel weighted average, heavy tails, geometric random walk