Robust High-dimensional Volatility Matrix Estimation for High-Frequency Factor Model

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High-frequency financial data allow us to estimate large volatility matrices with relatively short time horizon. Many novel statistical methods have been introduced to address large volatility matrix estimation problems from a high-dimensional Ito process with micro-structure noise contamination. Their asymptotic theories require sub-Gaussian or some finite high-order moments assumptions. These assumptions are at odd with the heavy tail phenomenon that is pandemic in financial stock returns and new procedures are needed to mitigate the influence of heavy tails. In this paper, we introduce the Huber loss function with a diverging threshold to develop a robust realized volatility estimation. We show that it has the sub-Gaussian concentration around the conditional expected volatility with only finite fourth moments. With the proposed robust estimator as input, we further regularize it by using the principal orthogonal component thresholding (POET) procedure to estimate the large volatility matrix that admits an approximate factor structure. We establish the asymptotic theories for such low-rank plus sparse matrices. The simulation study is conducted to check the finite sample performance of the proposed estimation methods.