Online Estimation of Time-Varying Volatility and Co-Volatility for Tick-by-Tick Data: A Bayesian Approach*

Jan C. Neddermeyer and Rainer Dahlhaus

Abstract.

For high-frequency trading it is essential to be able to estimate time-varying (co)-volatilities online based on tick-by-tick data. As a consequence of non-synchronous trading and the presence of market microstructure noise this is a challenging problem. We consider financial transaction data as observations of a latent efficient price process that are corrupted by (generalized) rounding noise. The proposed model reproduces the major stylized facts of high-frequency data such as the price discreteness and the first-order negative autocorrelation of the returns. It can be written as a nonlinear state-space model with non-synchronous observations. Based on this representation an efficient sequential Monte Carlo algorithm is designed that allows for approximation of the filtering distributions of the efficient price. The spot covariance matrix of the latent price process can be estimated as a parameter of the state-space model. For this purpose we propose a sequential EM algorithm that uses the output of the sequential Monte Carlo algorithm. Both constant and time-varying covariance matrices can be estimated online. The practical usefulness of our technique is verified through Monte Carlo simulations and through an application to US equity transaction data.

*University of Heidelberg, Institute of Applied Mathematics, Im Neuenheimer Feld 294, D-69120 Heidelberg, Germany. The first author has been supported by the University of Heidelberg under Frontier D.801000/08.023. (e-mail: jc@neddermeyer.net)