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Convergence of the Discrete Variance Swap in Time-Homogeneous Diffusion Models

Discretely sampled variance swaps are financial instruments whose price depends on the observed volatility or variance of an underlying. They are traded in the market, and usually the fair strikes of continuously sampled variance swaps are used to approximate their discrete counterparts. There has been work (Jarrow, Kchia, Larsson and Protter (2013)) discussing conditions under which this approximation is valid for semi-martingales, and also several papers proposing studying explicit formulae of discretely sampled variance swaps for specific stochastic volatility models, such as the Heston stochastic volatility model (Broadie and Jain (2008)), the Hull-White and the Schobel-Zhu stochastic volatility models (Bernard and Cui (2014)). For stochastic volatility models based on time-homogeneous diffusions, we provide a simple necessary and sufficient condition for the discretely sampled fair strike of a variance swap to converge to the continuously sampled fair strike, extending Theorem 3:8 of Jarrow, Kchia, Larsson and Protter (2013). We also give conditions (not based on asymptotics) when the fair strike of the discrete variance swap is higher than the continuous one and discuss the convex order conjecture proposed by Griessler and Keller-Ressel (2014) in this context. This is joint work with Carole Bernard, University of Waterloo, and Zhenyu Cui, Brooklyn College of the City University of New York.