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**Sequential Bayesian Learning for Stochastic Volatility
with Variance- Gamma Jumps in Returns**

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Discussion of 'Sequential Bayesian Learning for Stochastic Volatility with Variance-Gamma Jumps in Returns'

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I would like to congratulate Warty, Lopes and Polson (henceforth, WLP) for their interesting article developing a novel sequential Bayesian inference for the SVVG models of Madan and Seneta (1990). Inference for SVVGs poses challenges due to the nonlinearity of the model. Previous attempts for Bayesian analysis of SVVG's include the MCMC based approach of Li, Wells and Yu (2008) and the SMC method proposed by Jasra et al. (2011). The MCMC methods' computational inefficiency is well known for sequential Bayesian analysis. Use of SMC methods also pose potential challenges in updating the static parameters. These issues seem to be alleviated by the proposed approach of WLP who use the particle learning (PL) method of Carvalho et al. (2010) for updating the static parameters in the SVVG model. The attractive feature of the PL approach is the use of *conditional sufficient statistics* for the static parameters Θ for the SVVG model of equations (1)-(3). Availability of the sufficient statistics for all static parameters except the rate ν provides a computationally efficient updating scheme.

WLP presents a detailed comparison of their method with the MCMC approach of Li et al. (2008) and compare their model in Figure 7 with that of Jasra et al. (2011) where the rate ν is treated known. I would also like to see some brief discussion on how the PL approach compares with Jasra et al. (2011) in terms of computational efficiency. I would expect that for the case of known ν the PL approach should compare more favorably with the SMC. Any comments on this by the authors will be appreciated.

WLP point out the challenges in estimation of the rate ν in the model. I was wondering if it is possible to estimate ν by using off-line methods and then treat ν fixed in the model. Since static parameters usually converge to a region pretty quickly after observing some data, such an hybrid approach may work in some applications.

A multivariate generalization of Madan and Seneta variance gamma process has been proposed by Semeraro (2008). Following Semeraro's work other generalizations have been considered in the literature starting with Wang (2009). A recent review of these can be found in Buchmann et a. (2017) who presented a unification of these

models which involve multivariate Gamma subordination of Brownian motion jumps. I would like to see the authors comment briefly if they have considered an extension of the PL approach to the multivariate case and discuss feasibility as well as challenges of a multivariate extension. This is especially important for optimal portfolio selection problems as in Polson and Tew (2000) who considered single-period optimal portfolios. Portfolio selection in multivariate variance gamma models has been addressed by Hitaj and Mercuri (2013) based on classical methods. Also, the on-line updating via the proposed PL approach is attractive for the multi-period portfolio selection problems considered by Soyer and Tanyeri (2006). I would like to invite authors to comment on how plausible it is to use their approach for sequential decision problems.

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