Comment: Time Series analysis of non-Gaussian observations based on state space models from both classical and Bayesian perspectives

by

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The authors discuss the implementation of several time-series models, namely categorical state space, fat-tails and stochastic volatility (SVOL) models. While we are happy to see more work on these important areas, it is unclear how much this paper adds to the existing research. In particular, we are concerned about several aspects of the methodology: model specification, approximations, and the inlier problem. In addition, the paper would benefit from a comparison with the significant existing MCMC literature. For example, Carlin and Polson (1991) provide a MCMC solution for categorical state space time series models which is ignored here.

In regards to model specification, section 6.3 uses the normal error SVOL model developed in Jacquier, Polson and Rossi (1994a). Figure 6 shows normal posteriors, whereas JPR (1994a) find non-normality. JPR (1994b) provides a more flexible model, consistent with financial theory and the data. JPR (1994b) analyze the UK pound/$ exchange rate but with two extra effects 1) fat-tails (estimating ν) and 2) a correlation (or leverage effect ρ). Consider

$$\begin{aligned} y_t &= \sqrt{h_t}\sqrt{\lambda_t}\epsilon_t \\ \log h_t &= \alpha + \delta \log h_{t-1} + \sigma_v v_t \end{aligned} \tag{1}$$

where ϵ_t and v_t are *correlated* unit normals, and $\lambda_t \sim \nu/\chi^2(\nu)$, see Carlin and Polson (1991). ρ is needed for financial series. It produces the leverage effect, see Black (1976). It is unclear whether the authors method apply here.

JPR (1994b) again find non-normality and $p(\nu|\text{data})$ clearly demonstrates fat-tails (see figure) for £/$. Moreover, ρ is estimated precisely and away from 0 with mean -0.18. The Gaussian stochastic volatility model is clearly misspecified.

This misspecification affects predictions for individual volatilities. Consider the 1985 £/$ exchange rate. Notice the large value on August 29^{th}. The figure compares the basic and fat-tail SVOL models where the thick line is the mean of $\sqrt{h_t}$ from the basic model until August 29^{th}. The jagged line is the mean of $\sqrt{h_t \lambda_t}$ including fat-tails. h_t (not plotted) is the lower envelope of this line. The dotted lines give predictions one would make using either model. They are very different because h_t is persistent and λ_t is not. The outlier on August 29^{th} was captured mostly by λ_t. We need to model both λ_t and h_t.

Research has shown that likelihood approximations can lead to poor performance. JPR (1994a) provide a simulation study to compare their algorithm to the method of moments and QML. These simulations show that approximations can have a disastrous effect on performance. Another area of concern is the inlier problem, which the authors are aware of, where it is unclear that "adding a small value" will help, see Nelson (1994).

We are pleased to see the authors discuss these important models but would like to see comparisons with existing strategies.

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Fat Tail and Basic SVOL: Estimation and Smoothing, UK Pound to US Dollar