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RESEARCH ARTICLE

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Bayesian semiparametric Markov switching stochastic volatility model

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Abstract

This paper proposes a novel Bayesian semiparametric stochastic volatility model with Markov switching regimes for modeling the dynamics of the financial returns. The distribution of the error term of the returns is modeled as an infinite mixture of Normals; meanwhile, the intercept of the volatility equation is allowed to switch between two regimes. The proposed model is estimated using a novel sequential Monte Carlo method called particle learning that is especially well suited for state-space models. The model is tested on simulated data and, using real financial times series, compared to a model without the Markov switching regimes. The results show that including a Markov switching specification provides higher predictive power for the entire distribution, as well as in the tails of the distribution. Finally, the estimate of the persistence parameter decreases significantly, a finding consistent with previous empirical studies.

KEYWORDS

Bayes factor, Dirichlet process mixture, particle learning, sequential Monte Carlo

1 | INTRODUCTION

Volatility modeling has been of great interest in the last decades, especially after the recent financial crisis when the standard models failed to explain and predict the events that occurred in the financial markets. The two benchmark approaches to model volatility are based on the autoregressive conditional heteroscedasticity (ARCH)–type models, proposed by Engle,[1] and the stochastic volatility (SV) type models, proposed by Taylor.[2] The models differ in the underlying assumptions of the observability of the volatility. In ARCH-type models, the volatility is deterministic and observable, whereas, in the SV type models, the volatility states are latent and stochastic. By allowing for the volatility states to be stochastic, SV models provide more flexibility than the generalized ARCH (GARCH[3]) specifications (see the work of Broto and Ruiz[4] for example).

The SV model, as introduced by Taylor,[2] assumes the distribution of the error term of the returns to be Normal. Normal distribution was also considered by other works,[5-8] just to name a few. However, many empirical studies have shown that the returns exhibit heavy-tailed behavior (see related works[9-11] for example). One possibility, instead of Normal distribution, is to employ a distribution that allows for fat tails. The student-t distribution was used by other works[10-15]; the Normal-inverse Gaussian by Barndorff-Nielsen[16]; the mixture of Normals by Mahieu and Schotman[17]; and the generalized error distribution by Liesenfeld and Richard,[18] among many others. Another possibility is to abandon parametric assumptions for the distribution of the returns altogether and consider a semiparametric SV model.* In

*In some papers, such models are referred to as nonparametric SV models

