Opponent's Report on Dissertation Thesis

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Author:	**Ing. Milana Fičura**
Advisor:	prof. RNDr. Jiří Witzany, Ph.D.
Title of the Thesis:	**Modelling and Forecasting of Stochastic Volatility and Jumps**
Date of Defense:	September 26, 2018
Opponent	**Mgr. Lukáš Vácha Ph.D.**

This is a referee report on the PhD thesis of Milan Fičura entitled Modelling and Forecasting of Stochastic Volatility and Jumps completed under the supervision of prof. RNDr. Jiří Witzany, Ph.D.

The thesis under consideration is dedicated to volatility forecasting models, with a particular focus on the family of Stochastic Volatility Jump Diffusion (SVJD) models. The main contribution of the author is the extension SVJD model with the realized volatility parameter that may help to better estimate market volatility using the high-frequency data (SJVD-RV model) with the sampling frequency of 15-minutes. Further author improves the model with the inclusion of Z-estimator that enables jump detection in the stochastic volatility framework (SVJD-RV-Z model). This approach eliminates volatility estimation bias due to jump on high-frequency intraday data.

For the estimation of SVJD models, the author uses several adapted particle filters, specifically designed for latent-state filtering in SVJD model. Furthermore, a Sequential Gibbs Particle Filter algorithm is developed for the sequential learning of the parameters.

An important part of the thesis is an empirical section (Chapter 5), where the predictive performance of SVJD-type models is compared with GARCH, HAR, and Echo State Neural Network (ESN) family of volatility models. All models are tested using time series of 7 foreign exchange rates and 10 ETF/ETN

Results of the empirical part demonstrate that the SVJD-RV-Z model with jumps in volatility and prices, proposed by the author, exhibit the highest out-sample predictive power in comparison to other models.

Structure and the form of the thesis

The dissertation thesis is written in a competent manner and shows that the author has mastered his theoretical as well as computational skills. The thesis has a good structure, and

the introduction provides a clear overview of the dissertation. However, the exposition of well-known volatility estimators and concepts seems to be rather long as it covers almost half of the thesis. The author uses relevant literature and demonstrates that he is well acquainted with the contemporaneous literature in the field.

Comments/Questions for the defense:

1) In some parts of the thesis, it is not apparent what sampling frequency is used and whether is suitable for the models' estimation. For example, in the case of the semi-variance HAR (SHAR) model, I suppose the author uses 15-min intraday data. It means that there are about 25 observations available in total for both parts of the semivariance in a day. As we may expect some days are driven by strong positive/negative sentiment, then for the estimation of positive/negative semivariance one may be left with almost no data remaining for estimation of the corresponding part of the semi-variance. How can this fact influence the quality of the variance estimate (inference) and subsequent variance forecasting?

2) Another issue concerning the intra-day high-frequency data is related to the availability of suitable datasets for the jumps and realized measure estimation. Several of the datasets begin around the year 2000. The high-frequency trading was not that common it that times, so I wonder how many zeros in the returns time series is there. In other words, are there enough price movements during the day? If not, does it affect the jump estimators that are mainly based on continuous stochastic processes?

3) It is not clear why there is a difference in sign of jumps detected using simulated/filtered time series (Figure 4, p. 91 and other Figures below).

Conclusion

Overall, my assessment of the dissertation is very favorable. The dissertation thesis is of high quality and represents a valuable contribution to the field. The thesis proposes new important models and their estimation pushing the state of the current knowledge of volatility estimation. My comments above do not question the major contribution of this dissertation thesis. Thus, I recommend the dissertation thesis for the defense.

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