Discussion of **“Annual VaR from High Frequency Data”**

Alessandro Pollastri and Peter C. Schotman

Discussion by Patrick Tuijp | Ortec Finance, University of Amsterdam |
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Summary

- This paper investigates the properties of dynamic models for realized variance
- Focus: long-term Value-at-Risk and outcome relative to square-root-of-time rule
- Findings:
  - A fractional model implies a higher mean of the integrated variance for very long maturities and generates higher volatility of volatility
  - In the setting under consideration, the square-root-of-time rule seems to work approximately well

Summary (ctd.)

Setup:

- Returns normally distributed conditional on volatility.
- Obtain unconditional density of integrated variance from time series model for the logarithm of realized variance.
- Three different time series models:
    - Heterogeneous autoregressive (HAR), Corsi (2009); includes weekly and monthly average terms to capture long memory in addition to an AR(1) term
    - AR(1)
    - Fractionally integrated (FI), Andersen, Bollerslev, Diebold, and Labys (2003)

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Summary (ctd.)

Analyze scaling law under stable distributions

$$\mathrm{VaR}_T = T^{\frac{1}{\xi}} \mathrm{VaR}_{t+1}$$

through regression

$$\log \mathrm{VaR}_T = \beta_0 + \beta_1 \log T + u_T$$

Key question: how does relaxing the assumptions of volatility being *independent* and *identical* over time affect the square-root-of-time rule (i.e. $\xi = 2$)?

Also: alternate model-based approach to derive general scaling law.

Summary (ctd.)

Additional findings:

- Dynamics have a strong influence on long-term Value-at-Risk
- Fractional integration parameter: non-stationary, but mean reverting: $d \in [0.5, 1)$
- AR(1) displays higher first moment of integrated variance compared to HAR, but vastly lower standard deviation.

Conclusions:

- A fractional model implies a higher mean of the integrated variance for very long maturities and generates higher volatility of volatility
- In the setting under consideration, the square-root-of-time rule seems to work approximately well

General comments

- Relevant and topical paper! Issue is key in risk management
- Main comment: what is your benchmark case and why is it appropriate?
- It would help to start with a Monte Carlo analysis and only then consider empirical data
- Some things to explore in a Monte Carlo setting:
  - Impact of relaxing independent vs. identical volatility over time assumption
  - How does the proper scaling rule look in the cases you consider?
  - How does model risk factor in?

General comments

- Could you provide more intuition on your results? For instance, what is behind the higher mean and lower standard deviation of integrated variance in the AR(1) case relative to HAR?
- Would it help to measure the accuracy also by counting the frequency of observations below the threshold as in Beltratti and Morana (1999)?
- How do your results that higher persistence (under normality) leads to more conservative VaR estimates relate to Proposition 2 of Dacorogna, Müller, Pictet, and De Vries (2001), which shows that normality itself may be too conservative for VaR at longer horizons?

Minor comments

- Why do you look explicitly at stocks with different levels of persistence?
- What does your finding of $d \in [0.5, 1)$ (i.e. non-stationary but mean reverting) imply for the appropriateness of the AR(1) and HAR models for your data?
- Why do you use $\alpha = 0.6$ for your Local Whittle Estimator for d?
- In your Table 10, you find values of the tail index / stability index $\xi \in [1.96, 2.22]$. Are these large deviations from the square root case $\xi = 2$ or not?
- Could you provide more background on your proposed general scaling law in your equations (17) and (18)?

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Conclusion

- Highly relevant paper for risk managers, especially given the regulatory framework
- Many results and analyses, quite extensive in its coverage
- Would like to see a clear (Monte Carlo?) *benchmark case* as a background against which to evaluate the many results in the paper
- Could use more on what the separate impact is of relaxing different assumptions