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Optimally sampled realized range-based volatility estimators

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ABSTRACT

Range-based volatility estimators are analyzed in both daily and intraday sampling frequency and are also compared to the realized volatility estimator. The family of realized range-based estimators is extended as three range-based estimators are introduced. These three realized Parkinson range-based estimators are estimated in an optimal sampling frequency. Empirical analysis concerns three major US spot equity indices. The descriptive statistics and the long-memory estimations are compared between the daily and realized range-based estimators, and across each group as well. The realized range-based estimators are also compared in terms of the properties of the jump components of volatility. Moreover, the relevant effects of jumps on volatility are assessed by the use of the class of Heterogeneous Autoregressive (HAR) models.

1. Introduction

Estimation of volatility can be either parametric (e.g. GARCH) or nonparametric (e.g. squared daily returns, realized volatility). The data-driven, nonparametric volatility measures can provide direct ex-post measurement of notional volatility, without functional form assumptions like parametric measures. Banon (1978), Dohnal (1987), Genon-Catalot et al. (1992) and Florens-Zmirou (1993) are some of the most fundamental papers concerning nonparametric volatility estimation. In the family of nonparametric volatility estimators belong estimators using daily data and estimators using high-frequency intraday data. A group of estimators where data in both daily and intraday sampling frequency can be used is range-based estimators. The common feature of this group's estimators is that they all use the highest and lowest prices either in a daily or in an intraday (e.g. 5-minutes) in

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order to estimate volatility. These estimators are studied for some "stylized facts" about the time series properties of volatility like normality, clustering and long-memory. The realized range-based estimators are studied for the presence of volatility jumps. These four estimators can account the presence of jumps and, more importantly, to allow one to test for their presence and to separate the jump from the continuous component of volatility.

In this paper, three realized range-based estimators are introduced. The presence, properties and effects of jumps on the volatility estimated by four realized range-based volatility estimators besides the simple realized volatility estimator are empirically investigated. Using intraday data I first construct the realized range-based volatility estimators and then use these estimators as inputs in further analysis: in testing for jumps, in examining the properties of the resulting jump series and in modeling the jump component of U.S. volatility. I employ the methodology of Andersen et al. (2007), ABD hereafter, in testing for and modeling jumps. Their work, in turn, builds on earlier results of Barndorff-Nielsen and Shephard (2004, 2006, 2007). Christensen and Podolskij (2012) introduced a realized range-based multipower variation estimator; quite appropriate for detecting jumps upon range-based estimators as it is unbiased to jumps, according to their empirical findings upon simulated and real data as well. However, this paper employs the return-based power variation measure as the best unbiased-to-jumps volatility measure. The majority of the literature has followed that measure with success across various volatility estimators (for which the jumps are detected) and across various time periods and financial assets as well (see, Ait-Sahalia and Jacod, 2012; Dobrev and Szerszen, 2010; Thodorov, 2009; among others). This paper uses it because only such a benchmark (widely used in literature) unbiased-to-jumps volatility measure is the appropriate one in order to detect jumps upon the realized range-based estimators introduced in this paper. Of particular interest here are certain statistics of the jump component of volatility, such as the temporal dependence and duration of jumps. Then, I employ the class of Heterogeneous Autoregressive (HAR) models for assessing the relevant effects of jumps on volatility. In this type of models one can also disentangle the differential effect that the jump and continuous components have on volatility. The HAR class of models was introduced by Corsi et al. (2008) and Andersen et al. (2007) and extended by Corsi (2009). The analysis is performed for three international equity spot market indices, NDX, SPX and DJI indices, that have been highly studied in the literature.

Apart from realized volatility, close to Integrated Volatility also are the range-based estimators, which can treat the volatility as observable rather than latent as well. Estimating volatility by using the difference between the high and low prices, can be more efficient and less data demanding. This difference is called range. But using four data points – open, close, high and low prices – instead of two open-to-close (or close-to-open) or high-low prices can provide additional information, very important for revealing the properties of volatility estimates. When having access to this high-low prices, in either an intraday or daily sampling frequency, volatility is more accurately estimated. High-low prices allow us to get closer to the "real underlying process", even if we do not know the whole path of asset prices. The main advantages of the range as volatility measure, apart from data availability, are first the consistency, second its distributional properties, and third its robustness to certain types of market microstructure effects. The second advantage means that the maximized Gaussian quasi-likelihood is in fact not quasi-likelihood but the true likelihood. Concerning the third advantage, the range-based estimators do not have the problems of the bid-ask spread that the return-based estimators have. Moreover, the market microstructure noise affects less the range-based volatility than the realized volatility; see Hasbrouck (1999a,b) and Alizadeh et al. (2007). Consistency is depicted by analyzing the properties of four different range-based estimators and also in both intraday and daily frequency. Descriptive statistics and long-memory estimates answer about distributional properties. The robustness of the range to market microstructure effects is derived by comparing the properties of the range-based estimators to the realized volatility estimator (which is a highly efficient volatility proxy in the presence of these effects).[1] All three advantages are empirically proven.

[1] See ABD (2007).