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Correcting microstructure comovement biases for integrated covariance

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ABSTRACT

Finding a precise variance–covariance matrix is the building block of empirical finance. While microstructure-noise-robust methods for realized volatility are in the mainstream of financial econometrics, little if any attention has been devoted to estimating a noise-free realized covariance for overlooking the well-documented manifestation of commonality in market microstructure factors such as order flows, liquidity or herding. By documenting and recognizing this fact, we propose a microstructure-noise-free nonparametric covariance estimator to uncover the virtual integrated covariance. The estimator is easy to implement and performs admirably.

1. Introduction

Finding a relevant variance–covariance matrix for assets is the building block of strategic allocation and modern risk management. For asset pricing, second moments necessarily play a key role within a world where investors are risk-averse, and covariance terms can outnumber variance terms when the universe consists of multiple risky assets. In an applied sense, an accurate assessment of the covariance and correlation of key financial variables will have important benefits for portfolio managers, risk managers, and financial regulators alike. Constructing realized volatility (hereafter referred to as RV) via high-frequency information has became popular since Andersen et al. (2001), Barndorff-Nielsen and Shephard (2002), and the recent multivariate generalization in Barndorff-Nielsen and Shephard (2004).

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Understandably, the presence of market microstructure effects has pointed the microscope of econometric modelling at RV in order to focus on removing market microstructure noise contaminations (see Andersen et al. (2009) for a recent review). Moreover, when more than one asset is involved, the effect of non-synchronous trading among financial assets induces a severe bias towards zero in the covariance constructed from high-frequency data, and some recent treatments of the effect on realized covariances can be found in Hayashi and Yoshida (2005), Bandi and Russell (2007), Voev and Lunde (2007), Yeh et al. (2007), Barndorff-Nielsen et al. (2008), Zhang (in press) and Griffin and Oomen (in press) among others. Nonetheless, to our knowledge, the contemporaneous comovement in market microstructure noises has been overlooked in constructing realized covariance in the literature.

Our study attempts to highlight a new phenomenon that is distinct from the aforementioned effects from the empirical and methodological development points of view. Despite the well-documented evidence of commonality in order flows and liquidity attributed to program trading or style investing that might trigger correlated inventory fluctuations (see Chordia et al., 2000; Hasbrouck and Seppi, 2001), little if any attention has been devoted to knowing how these comovements in market microstructure noises influence the computation of realized covariance. To motivate this main idea and circumvent the effect of nonsynchronous trading, we compute the microstructure noise variations of four actively-traded equities on the NYSE, namely IBM, McDonalds, 3M, and Wal-Mart, from January 3, 2007 to April 30, 2009 using the estimator proposed by Hansen and Lunde (2006). The results are depicted in Fig. 1.

It is clear that each series of microstructure noise variations exhibits strong comovements across time and the correlations among these series of pairs in IBM/MCD, IBM/MMM, IBM/WMT, MCD/MMM, MCD/WMT, and MMM/WMT are relatively high, being 0.772, 0.801, 0.591, 0.818, 0.821, and 0.899, respectively. Given this observation, of equal interest would be a version of the noise-free estimator that takes account of the commonalities in these microstructure factors. Although mainstream bias-correction methods for RV are effective in being free from asset-specific market microstructure noise, they are silent in regard to this commonality. That is, merely performing bias-correction in the diagonal elements does not suffice to provide an accurate realized variance–covariance matrix for further financial applications since those off-diagonal covariance terms and the subsequent correlations may be seriously biased due to the noise comovements.

This article sheds light on two perspectives. We show how biased and misleading the classical realized volatility and covariances can be when market microstructure noises share commonality. We then propose a bias-corrected estimator based on the idea of Yeh and Wang (2008) to uncover the virtual integrated covariance (IC henceforth) among efficient returns. Through both the Monte Carlo experiments and an empirical study, we show that the easy-to-implement noise-free estimator performs admirably in delivering a more precise realized covariance matrix and realized correlation matrix as well in the absence of asynchronous trading.

2. Realized variance–covariance

Suppose the logarithm of a k-vector diffusion process $\boldsymbol{p}(t)$ follows:

$$d\boldsymbol{p}(t+\tau) = \boldsymbol{\mu}(t+\tau) + \boldsymbol{\Theta}(t+\tau)d\boldsymbol{W}(t+\tau), \quad 0 \leqslant \tau \leqslant 1, \ t = 1, 2, \ldots, \tag{1}$$

where $\boldsymbol{\mu}(t+\tau)$ is the multivariate drift component, $\boldsymbol{\Theta}(t+\tau)$ is the instantaneous co-volatility matrix and $\boldsymbol{W}(t+\tau)$ is the standard multivariate Brownian motion.[1] Assume that $\boldsymbol{\Theta}(t+\tau)$ is orthogonal to $\boldsymbol{W}(t+\tau)$. The instantaneous covariance matrix is $\boldsymbol{\Sigma}(t+\tau) = \boldsymbol{\Theta}(t+\tau)\boldsymbol{\Theta}(t+\tau)'$ with generic elements given by $\Sigma_{(u)(s)}(t+\tau)$.

Having becoming popular since the seminal pieces of Andersen et al. (2001) and Barndorff-Nielsen and Shephard (2002), the recent studies by Andersen et al. (2009) and Barndorff-Nielsen and Shephard

[1] We rule out the leverage effect, that is, correlation between the return innovations and volatility. The recent literature is seeking to loosen this assumption, and one should explore practical performance when this assumption is violated. However, this effect does not rule out the usefulness of our estimator. We thank the anonymous referee for pointing this out.