Available online at www.sciencedirect.com
SCIENCE DIRECT®
ELSEVIER
Journal of Financial Economics 79 (2006) 655–692
JOURNAL OF Financial ECONOMICS
www.elsevier.com/locate/jfec

Separating microstructure noise from volatility ☆

Federico M. Bandi*, Jeffrey R. Russell

Graduate School of Business, University of Chicago, Chicago, IL 60637, USA

Received 25 February 2004; received in revised form 17 January 2005; accepted 15 February 2005
Available online 10 October 2005

Abstract

There are two variance components embedded in the returns constructed using high frequency asset prices: the time-varying variance of the *unobservable* efficient returns that would prevail in a frictionless economy and the variance of the equally *unobservable* microstructure noise. Using sample moments of high frequency return data recorded at different frequencies, we provide a simple and robust technique to identify both variance components.

In the context of a volatility-timing trading strategy, we show that careful (optimal) separation of the two volatility components of the observed stock returns yields substantial utility gains.

JEL classification: G12; C14; C22

Keywords: Volatility; Volatility timing; Microstructure noise; High frequency data

1. Introduction

The logarithm of a recorded asset price can be written as the sum of the logarithm of the efficient price and a noise component that is induced by microstructure frictions, such as price discreteness and bid-ask bounce effects. Accordingly, the variance of continuously

☆ We thank Laurence Lescourret, Benoit Perron, and seminar participants at the conference "Analysis of high frequency data and market microstructure," Taipei (Taiwan), December 15–16, 2003, the conference "Econometric forecasting and high frequency data analysis," Singapore, May 7–8, 2004, the European Finance Association Meetings, Maastricht (Netherlands), August 20–22, 2004, and the American Finance Association Meetings (Philadelphia), January 7–9, 2005, for discussions. We thank the editor, Bill Schwert, and a referee for comments that led to substantial improvement of the paper.
*Corresponding author. Fax: +1 773 702 0458.
E-mail address: federico.bandi@gsb.uchicago.edu (F.M. Bandi).

0304-405X/$ - see front matter
doi:10.1016/j.jfineco.2005.01.005

compounded returns based on recorded logarithmic prices depends on the variance of the underlying efficient returns and the variance of the microstructure noise components in returns. Both variance measures carry a fundamental economic significance. The variance of the efficient return process is a crucial ingredient in the practise and theory of asset valuation and risk management. The variance of the microstructure noise component reflects the market structure and the price setting behavior of market participants and thereby contains information about the market's fine-grain dynamics.

The availability of high frequency data provides researchers with an opportunity to learn about financial return volatility through robust identification methods that are simple to implement in that they are based on straightforward descriptive statistics (see the literature review of Andersen et al., 2002). Nonetheless, the observation that recorded asset prices sampled at high frequencies contain a nonnegligible microstructure friction component has imposed theoretical and empirical limitations on the exploitation of the informational content of high frequency data. This paper contributes to the literature on nonparametric variance estimation through high frequency data by re-evaluating the identification potential of high frequency data. Specifically, we show that both *unobserved* components of the variance of recorded asset returns can be estimated using high frequency data sampled at different frequencies. Very high frequency asset price data can be employed to consistently estimate the microstructure noise variance. Data sampled at lower frequencies can be utilized to learn about the efficient return variance. While this latter fact is recognized in the literature, albeit not formally studied (see Andersen et al., 2001, for instance), we provide a rigorous and easily implementable procedure to purge high frequency return data of their microstructure components and extract information about the true variance dynamics by sampling at optimal frequencies. In this context, we show that the economic benefit of optimal sampling can be substantial.

Our procedure builds directly on the work of French et al. (1987), Schwert (1989, 1990a,b), Schwert and Seguin (1991), and more recently, Andersen et al. (2001), Andersen et al. (2003), and Barndorff-Nielsen and Shephard (2002, 2004). As in the early literature, as represented by French et al. (1987) for example, we measure variance by using sample averages of squared return data. In agreement with the recent work of Andersen et al. (2001), Andersen et al. (2003), and Barndorff-Nielsen and Shephard (2002, 2004), we provide robust theoretical justifications for our variance estimates in the context of a continuous-time specification for the evolution of the underlying logarithmic price and the availability of high frequency return data. In contrast to both the early approaches to nonparametric variance identification and the current work on realized variance estimation, we do not simply focus on the variance dynamics of recorded stock returns; rather, we aim to identify *both* the variance of the efficient return component and the variance of the microstructure contaminations by exploiting the considerable information potential of high frequency return data.

The first stage of our analysis makes use of data sampled at the highest possible frequency. In recent work, Bandi and Russell (2004) show that sample second moments constructed using *observed* high frequency return data provide consistent estimates of the second moment of the *unobserved* microstructure frictions in a canonical model of price determination with MA(1) microstructure noise. We use this result to identify the variance of the noise component in the recorded return data. This procedure represents the substantive core of the identification of the variance of the zero-mean microstructure noise.