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Long memory features in the high frequency data of the Korean stock market

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ABSTRACT

This paper examines the long memory property in the high frequency data of KOSPI 200 using the FIAPARCH model. The empirical results indicate that the FIAPARCH model can capture asymmetry and long memory in the volatility of intraday KOSPI 200 returns. Interestingly, the presence of long memory is invariant to the temporally aggregated intraday returns, implying that a long memory phenomenon is an inherent characteristic of the data generating process, not a result of structural breaks.

1. Introduction

Shocks to a financial market may have a significant impact on its volatility [1–6]. An important issue in designing investment strategies (e.g., choice of an investment horizon) is whether the financial volatility affects of shocks will display short memory or long memory. In light of the importance of long memory in financial markets, numerous studies have tested for evidence of long memory in volatility [7–26].

Although this rapidly evolving subject has produced many empirical studies of the presence or otherwise of long memory properties, much less work has examined the origins of long memory in volatility. A common explanation for the origin of long memory is the issue of structural breaks, which can easily be confused with a long memory process in a time series. In other words, structural breaks may make it appear that a time series has generated spurious persistence in volatility [27].

The primary objective of this paper is to test for the source of the long memory property, using the high frequency data of the Korea Composite Stock Price Index 200 (KOSPI 200). Andersen and Bollerslev [28,29] suggested that a resolution to this problem might lie in examining whether long memory volatility processes can be invariant with respect to aggregated temporal data. In this perspective, the same degree of long memory property over data of different frequencies indicates a self-similar or fractal structure of a data generating process. By doing it thus, we use the fractionally integrated asymmetric power ARCH (FIAPARCH) model of Tse [30] over various time scale intraday returns. To add robustness to our analysis, the FIAPARCH model is applied under a Student-t distribution assumption [1,17,31,32].

In addition, this study initially investigates an intraday periodicity in the 10 minute (10-min) intraday returns. Many studies have documented the intraday periodicity, or U-shaped pattern. In developed markets, market volatility is relatively

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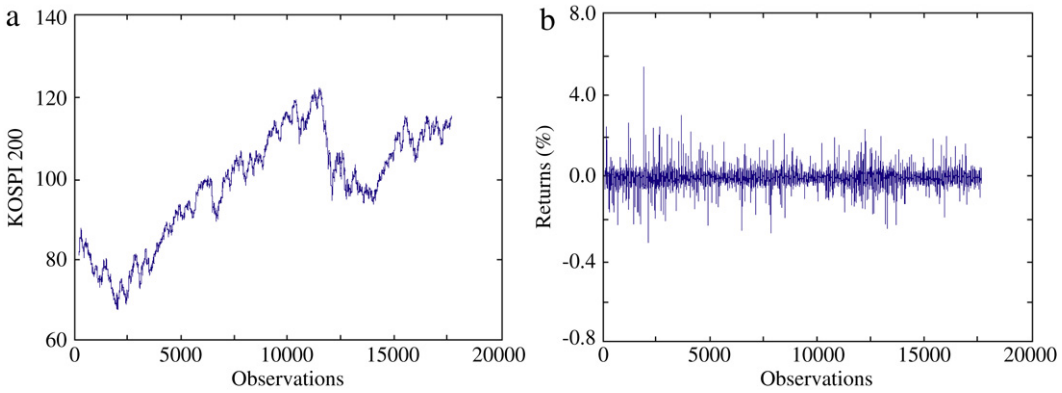

Fig. 1. Descriptive graphs for 10-min KOSPI 200: (a) level of price, (b) returns.

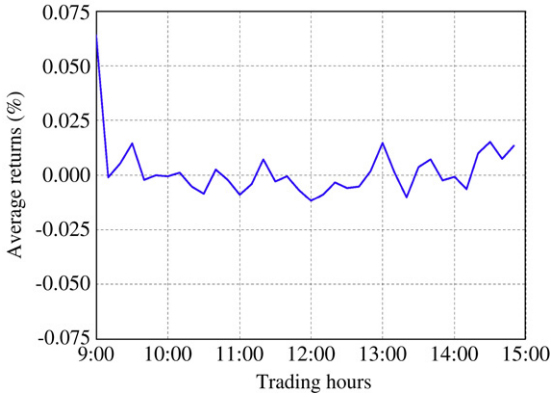

Fig. 2. Average returns for the 10-min KOSPI 200 returns.

high at the opening and closing of the trading day but low in the middle of the day [28,29,33–35]. However, only a few studies have been made of the intraday periodicity of emerging markets including Korea. Cajueiro, Tabak and Souza [36] indicated that the intensity of the long memory phenomena depends on the intraday periodicity, due to trading mechanisms and the flow of information in the Brazilian market. Therefore, understanding the intraday periodicity of emerging market stock prices is of importance as they might exhibit characteristics different from those observed and well documented in developed markets, contributing to different dynamics underlying volatility.

The structure of our paper is as follows. The next section discusses the basic properties in the volatility of high frequency stock returns. Intraday periodicity and volatility persistence are presented in terms of the level of returns, square returns and absolute returns. Section 3 presents some of the important characteristics of the FIAPARCH model. The FIAPARCH model can express both the asymmetric feature and the long memory property in volatility. Section 4 presents the empirical results of the asymmetric long memory feature in the volatility of KOSPI 200 intraday data. The final section provides brief conclusions.

2. High frequency data of KOSPI 200

This paper constructs the 10-min KOSPI 200 prices from the tick-by-tick data provided by the Korean Exchange (KRX), in which the intraday data of KOSPI 200 were taken, every 10-min interval, for the entire two calendar years, commencing on January 2, 2003 and ending on December 30, 2004. The 10-min KOSPI 200 prices consist of 36 intervals per day from 9 a.m. to 3 p.m., covering 17,832 data points. The 10-min returns at time n on day t are defined as

$$R_{t,n} = \ln\left[\frac{p_{t,n}}{P_{t,n-1}}\right], \quad t = 1, 2, \ldots, 496 \quad \text{and} \quad n = 1, 2, \ldots, 36, \tag{1}$$

where n is the number of 10-min time intervals in the day, and t is the number of trading days in the sample period. Fig. 1 displays descriptive graphs of 10-min (a) prices and (b) returns over the sample period.

To explore the intraday periodicity of the KOSPI 200 returns, we calculated the average sample returns and their standard deviations in each 10-min interval during working hours. As Fig. 2 shows, during the initial 10-min interval, from 9:00 to 9:10 a.m., strong positive returns are shown due to the impact of market opening effects and, thereafter, the average returns