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Modelling time-varying volatility in the Indian stock returns: Some empirical evidence

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Abstract

This paper models time-varying volatility in one of the Indian main stock markets, namely, the National Stock Exchange (NSE) located in Mumbai, investigating whether it has been affected by the recent global financial crisis. A Chow test indicates the presence of a structural break. Both symmetric and asymmetric GARCH models suggest that the volatility of NSE returns is persistent and asymmetric and has increased as a result of the crisis. The model under the Generalized Error Distribution appears to be the most suitable one. However, its out-of-sample forecasting performance is relatively poor.

JEL classification: C15; C50; G17

Keywords: Volatility; GARCH; Financial crisis

1. Introduction

Since the seminal papers of Engle (1982) and Bollerslev (1986) several studies have used ARCH/GARCH specifications to model the time-varying volatility of stock returns. Most of them have focused on the mature markets. Only a few have provided evidence for the emerging economies. In particular, Lee et al. (2001) examined volatility in the Chinese stock market, and Olowe (2009) and Kaur (2004) in the Nigerian and Indian ones respectively. Other authors (Bekaert and Harvey, 1997; Aggarwal et al., 1999; Mookerjee and Yu, 1999; Lee et al., 2001; Kaur, 2004; etc.) have examined time varying-volatility models using daily data for other emerging countries. Wei (2002) examined Chinese weekly data instead. Zhou and Zhou (2005) tested for cointegration between Chinese stock markets using daily data before and after Hong Kong's return to China. Finally, Tripathy and Gil-Alana (2010) carried out a volatility forecasting exercise for the Indian stock market using five different models: (i) Historical/Rolling Window Moving Average Estimator, (ii) Exponentially Weighted Moving Average (EWMA), (iii) GARCH models, (iv) Extreme Value Indicators (EVI) and (v) Volatility Index (VIX). Their results suggest that the EVI model (followed by the GARCH and VIX models) have the best forecasting properties.

The present study provides additional evidence on volatility behaviour in the Indian market, and it also investigates whether this has been affected by the recent financial crisis. Specifically it focuses on the National Stock Exchange (NSE) located in Mumbai. This is one of the 20 largest stock exchanges in the world by market capitalization and the largest in India by daily turnover and number of trades; for both equities and derivative trading it has a market capitalization of around US$1 trillion and over 1652 listings as of July 2012. NSE is mutually owned by a set of leading financial institutions, banks, insurance companies and other financial intermediaries in India but its ownership and management operate as separate entities. There are two foreign investors, NYSE Euronext and Goldman Sachs, with a stake

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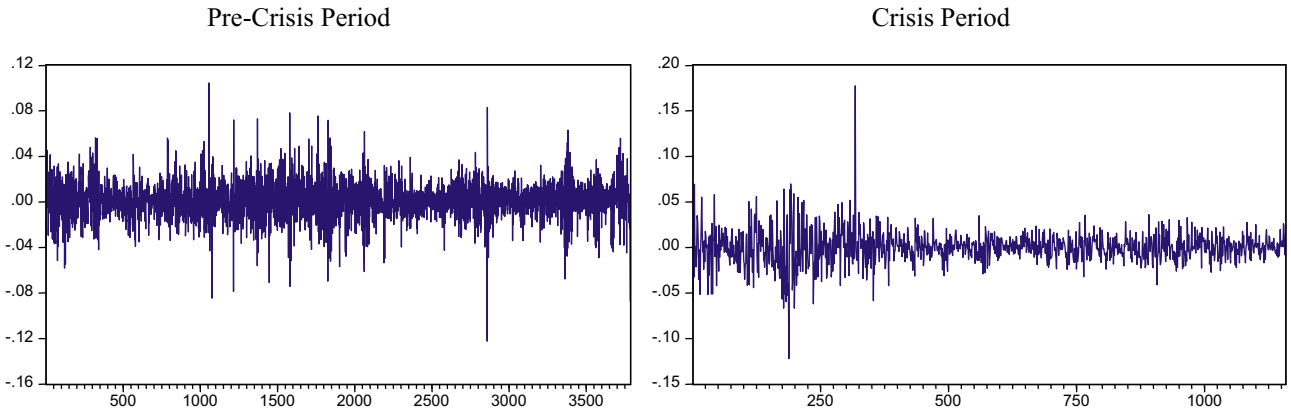

Fig. 1. Daily returns volatility in NSE, pre-crisis (N) and crisis (NN) periods-Jan 22nd, 2008.

in the NSE. The NSE VSAT[1] terminals, 2799 in total, cover more than 1500 cities across India. In 2011, the NSE was the third largest stock exchange in the world in terms of the number of contracts (1221 million) traded in equity derivatives. It is the second fastest growing stock exchange in the world with a recorded growth of 16.6%.

The specific objectives of this paper can be summarized as follows: (i) to estimate the degree of volatility in the closing values of NSE, (ii) to examine the leverage effect in the Indian stock market before and after the global crisis and (iii) to forecast the future volatility in the NSE return series. The hypotheses to be tested for the stock returns are the following: (1) they do not exhibit asymmetric volatility, (2) their volatility has been higher during the crisis period and (3) there is no leverage effect in the Indian stock market.

The remainder of the paper is organized as follows: Section 2 describes the data and the empirical analysis. Section 3 offers some concluding remarks.

2. Data and empirical analysis

2.1. Data

We analyze the closing prices of the S&P CNX Nifty, which are collected from the official website of the National Stock Exchange of India ltd. (NSE).[2] The sample period extends from the 3rd of August 1992 to the 21st of September 2012, and includes 4942 data points.

To examine the possible presence of structural change in the data, we carried out a Chow breakpoint test for the Nifty series by choosing the 22nd of January 2008 as the break date. The logic of testing the series break test on this date emanates from the fact that the Nifty 50 crashed by over 12% (630 points) and BSE mid-cap slid by 11.38% and Small-cap dipped by 10.27%, registering a record single-day fall. This sharp intraday decline in major Indian stock indices occurred due to the US stimulus package failing to break-up the fears over the US economic recession. The Chow break point test statistic confirms the existence of such a break on January 22, 2008. This is consistent with Gil-Alana and Tripathy (2012), finding a break in the NSE data on this particular date, when examining the break by implementing the procedure developed by Gil-Alana (2008) in the context of fractional integration. Hence, we split the sample into two sub-samples and refer to the period from 3rd August, 1992 to 21st January, 2008 as the pre-crisis period, and that from 22nd January, 2008 to 21st September, 2012 as the crisis period.

Table 1
Descriptive statistics for NSE returns.

Statistics	Pre-crisis	Crisis
Mean	0.0006	0.0002
Median	0.0009	0.0005
Std. Dev.	0.0160	0.0183
Skewness	−0.1748	0.5710
Kurtosis	6.6601	13.1944
Jarque–Bera	2131***	5077***
Sum Sq.Dev.	0.9721	0.3893
Observations	3784	1158

Source: Estimated by the Authors.
*** 1% level of significance.

Table 1 reports summary statistics for the daily return series of the NSE. Daily mean returns are higher during the pre-crisis period and their standard deviation during the crisis period. The distribution of the return series is negatively and positively skewed during the pre-crisis and crisis periods respectively. Kurtosis is higher during the crisis period. In brief, the return series is concentrated around the mean, but exhibits fatter tails and sharper peaks in comparison to the standard normal distribution. The Jarque–Bera test statistics confirm that the return series is not normally distributed (Table 1).

Fig. 1 displays the plots of the return series in the two subperiods. Heteroscedasticity is clearly present, whilst the mean

[1] VSAT – Very Small Aperture Terminal. It is a type of two-way satellite that transmits both narrow and broadband data to satellites in orbit. The data is then redirected to other remote terminals or hubs around the planet. VSATs are mainly used for wireless transmission of real-time data The NSE uses a real-time online application, which is supported by 15 computer systems, including non-stop, fault-tolerant computers and high-end UNIX servers.

[2] www.nse-india.com.