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ABSTRACT

This study investigates correlations between India's bustling single stock futures (SSFs) and its peculiar Badla mechanism. Data from the world's most active SSF market, the National Stock Exchange (NSE) of India, are used. The results indicated that both the Badla mechanism and the introduction of SSFs seem to have contributed to the higher volatility of the spot markets. Our results show that the NSE's success with SSFs can be attributed to the peculiar trading conventions of the Badla system. However, we propose that this success could come at the cost of market disability, suggesting that there is justification for strengthening market regulations.

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Introduction

Since the first of the single stock future (SSF) contracts was launched on the Sydney Futures Exchange (SFE) in Australia on May 16, 1994, SSFs have been listed on another 20 exchanges globally. Table 1 provides a summary of the world's top ten active SSF exchanges.

To our surprise, India's National Stock Exchange (NSE) outperforms others in terms of the SSF trading volume. The trading volumes of SSFs for the NSE are about 13 times those of OneChicago, which is the well-known headquarters of the derivatives market. NSE has become the world's busiest SSF trading center since November 9, 2001, when SSFs were formally listed and trading began. As the most active SSF market in the world, the NSE of India has been sharing its successful experiences with exchanges worldwide that are eager for access to SSFs. Although there have been some studies of India's SSF market (for example, Mohan, Kumar, & Pappu, 2002), there has been little attention given to the relationship between the success of NSE's SSF business and India's conventional trading mechanism, Badla.

Badla is a peculiar mechanism that has operated for several decades in India. It is a trading system initiated by the Bombay Stock Exchange (BSE).[1] This futures-like mechanism allows traders to carry a large long or short net position forward to the next settlement period so that traders can accumulate adequate positions to hedge or avoid delivery for months. A comparison of Badla and futures is presented in Table 2. The Badla has three functions in the equity market; that is, as a quasi-hedging mechanism, a stock lending mechanism, and a financing mechanism. To protect the market structure and the regulatory framework, Badla was first banned by the Securities and Exchange Board of India (SEBI) in 1993 (effective March 1994). It was then legalized again in 1996, partially because the exchange was not ready for the modern derivatives market, and partially because of the brokers' strenuous lobby.

Besides the BSE, the NSE also introduced its own version of badla, which was called the Automated Lending and Borrowing Mechanism (ALBM). Much younger than the BSE with its long history, the modern NSE was established in November 1992 by government-sponsored institutions. To catch up with the open positions and turnover rates of the stocks on the BSE, the NSE introduced the ALBM in February 1999 to neutralize the advantage of the BSE. Although the ALBM has some operational differences from the BSE's Badla version, they are conceptually the same. According to data from 2001, the NSE permits ALBM in 175 stocks, compared to the BSE's 142 "A-group" Badla stocks.

Later on, when the trading mechanisms for derivatives were established within the NSE, SSFs were introduced to India's investors. Anand Rathi, the ex-president of BSE, said in his interview with Business Line, "Badla combines all the economic functions of the capital market with the financial functions in one product. In other parts of the world, all this is available separately. The day all these products are available in India, I don't think anybody would need Badla." Finally, Badla became history when banned on July 2, 2001. Since then, the equity trading system adopted rolling settlements, to be done on a T+5 basis.[2] On November 9, 2001, SSFs were formally listed, and began trading on the National Stock Exchange of India.

During its tumultuous history, Badla has played a very important role in India's trading market. Although SSFs are derivatives, Indians have adapted to the products easily. Since Badla and SSFs share some properties, we suggest that NSE's success with SSFs may be attributed to the peculiar conventional mechanism, Badla.

Since the trading of futures and other derivatives has become more frequent in recent years, a growing number of studies have been done to examine the influence of derivatives trading on the underlying stock markets. Some report that derivatives trading results in higher underlying stock market volatility (see, for example, Figlewski, 1981; Conrad, 1989; Harris, 1989; Damodaran, 1990; Harris, Sofianos, & Shapiro, 1994; Antoniou & Holmes, 1995; Antoniou, Holmes, & Priestley, 1998; Gulen & Mayhew, 2000; Rahman, 2001; Bae, Kwon, & Park, 2004). However, there is significant academic dissent to this view, which argues that the introduction of derivatives lowers (or has no significant effect on) the volatility of the underlying stock markets (see, for instance, Ma & Rao, 1988; Edward, 1988; Choi & Subrahmanyam, 1994; Pericli & Koutmos, 1997; Lee & Tong, 1998; Illueca & Lafuente, 2003; Spyrou, 2005). To investigate the conjectures of the current study, we must first determine whether Badla and the introduction of SSFs had a similar impact on the underlying stock market.

However, as summarized in Antoniou, Holmes, and Priestley (1998), changes in volatility may be both desirable and undesirable. One view blames increased volatility after the introduction of derivatives trading by speculators. These forces, destabilizing to the underlying market, have been traditionally considered undesirable consequence of the introduction of derivatives. Since derivatives such as futures are highly leveraged products, they are attractive to uninformed market participants. Trading without information, such noise traders cause prices in both derivatives and cash markets to deviate from their fundamental value. However, another viewpoint emphasizes the attraction that derivatives exert on additional informed traders. The transmission of news is improved, resulting in a more efficient impounding of information on prices. Increases in volatility based on this may be viewed as a desirable consequence of the introduction of derivatives.

Nevertheless, the information flows are difficult to measure, and the extent to which the price variability is driven by noise or information is hard to determine. Until Andersen (1996) proposed the Generalized Method of Moments approach (GMM) to test this, a direct examination of the Mixture of Distribution Hypothesis[3] (MDH) could not be undertaken. Based on the premise that a series of moment-based conditions should be satisfied under the validity of the MDH, Andersen's method helps to identify the roles information and noise play in the price-generating process. Utilizing Andersen's (1996) method, Holmes and Tomsett (2004) concluded that, for the three examined U.K. futures markets, the MDH was supported, and information was the main force affecting price variations.

As we know, by making market prices a mixture of the value of the share and the futures price of the share, Badla was notorious for its distortion of market signals. In hindsight, the banning of Badla may have been warranted, since trading on the "wrong" price could be avoided. If we find that Badla and the introduction of SSFs had a similar impact on the underlying stock market, then it will be reasonable to infer that changes in volatility after the introduction of SSFs could also have been the result of noise.

Instead of improving the transmission of news, the introduction of SSFs could destabilize the cash market as well as the futures market. To support our hypotheses, we must next determine whether the price variability is desirable or undesirable, using Andersen's method to establish the driving force behind the price changes.

This paper will continue as follows: the data used are described in Section 2, the methodology employed is described in Section 3, the empirical results are presented in Section 4, and the conclusions of the paper are presented in the final section.

2. Data

The data used in this study were obtained from the National Stock Exchange of India (NSE) database. Currently, the NSE has SSF contracts traded on 226 individual stocks. The contracts have delivery dates over three consecutive months. The contracts are settled in cash. In addition, there are specific daily price movement limits and position limits.

The data used in this research consist of the top ten active single stock future contracts (SSF) listed on the NSE. Among these ten underlying stocks, four belong to the banking industry, two belong to the information technology industry, two belong to the energy industry, one belongs to the cement industry, and one belongs to the petrochemical industry. All of them adopted the ALBM until July 2, 2001.

The data cover SSFs from the date they were introduced to May 31, 2005, and their corresponding underlying stocks from April 1, 1999 to May 31, 2005.[4] To determine whether the underlying stock returns are influenced by the Badla, or by the introduction of the SSF contracts, we divided the data periods into three groups; i.e., the Badla period, the transition period, and the post-introduction period, as shown in Table 3. A comparison of the average trading volume for the three sub-periods, as well as that for the SSF contracts, is illustrated in Table 4 and Figure 1.

Although the market experienced a shrinking trading volume following the banning of Badla in 1993, only three securities among the ten actually decreased in volume during the transition period, as shown in Figure 1. The introduction of the

SSFs also contributed to the larger trade volume of underlying stocks. From Figure 1, we observe that seven of the ten securities had even greater trading quantities than they had during the Badla period.

3. Methodology

The daily returns of the underlying stock (r_t) were computed by $\ln(\frac{p_t}{p_{t-1}})$, where p_t and p_{t-1} are close prices at time *t* and time *t-1*.

As listed in Table 5, we found that the variances in the underlying stock returns show slight differences between the three groups.

However, when we plotted ACF and PACF graphs of the series r_t and r_t^2, we found that autocorrelation of r_t was very low, while autocorrelation of r_t^2 was quite high. (To save space, the ACF and PACF graphs are omitted here.) This implies that even though we could claim that r_t was serially uncorrelated, we could not jump to the conclusion that r_t was serially independent. Hence, volatility models were employed to capture such dependence in the series r_t.

Bollerslev (1986) proposed a useful extension of ARCH, known as the generalized ARCH (GARCH) model to avoid estimating too many parameters in the ARCH model. Akgiray (1989) reported that, compared with various ARCH models, GARCH (1,1) performed best on estimating conditional volatility. Hence, we began with the assumption that the conditional variance of the daily returns of the underlying stocks has the form of GARCH (1,1). The GARCH (1,1) model used in our research is as follows:

$$h_t = \alpha + \beta r_{t-1}^2 + \gamma h_{t-1}, \tag{1}$$

where h_t and h_{t-1} are the current and lagged values of conditional variance of the underlying stock daily returns and r_{t-1}^2 is the lagged value of the squared return.

After estimating the parameters in Equation (1) for the returns of the Badla period, the transition period, and the post-Introduction period, we adopted the statistic suggested by Harnett and Soni (1991) to test for significant differences in the estimated parameters for the pre and post periods. Rahman (2001) employed this statistic and concluded that the conditional volatility in the DJIA spot market exhibited no structural changes caused by the introduction of index futures or futures options. Hung, Lee, and So (2004) applied this statistic to show that the introduction of the foreign listed SSF contracts seems to have explanatory power with respect to the higher volatility of their domestic spot markets. The statistic is described as follows:

$$t^* = \frac{(\bar{x}_{pre} - \bar{x}_{post}) - (\mathcal{M}_{pre} - \mathcal{M}_{post})}{\sqrt{\left(\frac{\left((n_{pre}-1)\hat{\sigma}^2_{pre}\right) + \left((n_{pre}-1)\hat{\sigma}^2_{pre}\right)}{n_{pre}+n_{post}-2}\right)\left(\frac{1}{n_{pre}} + \frac{1}{n_{post}}\right)}}, \tag{2}$$

where $\bar{x}_{pre}$ ($\bar{x}_{post}$), $\hat{\sigma}^2_{pre}$ ($\hat{\sigma}^2_{post}$), and n_{pre} (n_{pre}) are the sample mean, sample variance, and sample size of β or γ for all 10 stocks for the pre and (post) period, respectively; $\mathcal{M}_{pre}$ and $\mathcal{M}_{post}$ are the respective population means. The statistic follows a t distribution with a ($n_{pre} + n_{post} - 2$) degree of freedom.

In order to examine whether noise or informed traders dominate the cash market, we tested the modified Mixture of Distribution Hypothesis (MDH). Another model suggested by Andersen (1996) was employed. The structure of the modified MDH is organized as following:

$$V_t = NV_t + IV_t \tag{3}$$

$$r_t | I_t \sim N(\bar{r}, I_t) \tag{4}$$

$$\hat{V}_t | I_t \sim c \cdot Po(v_0 + v_1 I_t) \tag{5}$$

where V_t is the daily trading volume made up by noise trade (NV_t) and informed trade (IV_t) ; r_t is the daily return;[5] $\hat{V}_t$ is the detrended volume;[6] I_t is the unobserved number of information arrivals; c is a constant for the detrending process; Po is a Poisson distribution;[7] v_0 and v_1 are the noise and informed components of volume, respectively.

Combining Equations (4) with Equation (5), Andersen (1996) constructed twelve equations that include an unconditional mean, volume, and cross moments to deduce the implication of the MDH. The following twelve equations each represent a different characteristic of the MDH:

$$E[r_t] = \bar{r} \tag{6}$$

$$E[r_t - \bar{r}] = (2/\pi)^{1/2} E[I_t^{1/2}] \tag{7}$$

$$E[(r_t - \bar{r})^2] = E[I_t] = \bar{I} \tag{8}$$

$$E|r_t - \bar{r}|^3 = 2(2/\pi)^{1/2} E[I_t^{3/2}] \tag{9}$$

$$E\left[(r_t-\bar{r})^4\right]=3E\left[\bar{I}^2+\operatorname{var}(I_t)\right] \tag{10}$$

$$E\left[\hat{V}_t\right]=c\left(v_0+v_1\bar{I}\right)=\overline{V} \tag{11}$$

$$E\left[\left(\hat{V}_t-\overline{V}\right)^2\right]=c\overline{V}+c^2v_1^2\operatorname{var}(I_t) \tag{12}$$

$$E\left[\left(\hat{V}_t-\overline{V}\right)^3\right]=c^2\overline{V}+3c^2v_1^2\operatorname{var}(I_t)+c^3v_1^3E\left[K_t-\bar{I}\right]^3 \tag{13}$$

$$E\left[R_t\hat{V}_t\right]=\bar{r}\overline{V} \tag{14}$$

$$E\left[|r_t-\bar{r}|\left(\hat{V}_t-\overline{V}\right)\right]=c(2/\pi)^{1/2}v_1\left(E\left[I_t^{3/2}\right]-E\left[I_t^{1/2}\right]\right) \tag{15}$$

$$E\left[(r_t-\bar{r})^2\hat{V}_t\right]=\overline{VI}+v_1\operatorname{var}(I_t) \tag{16}$$

$$E\left[(r_t-\bar{r})^2\left(\hat{V}_t-\overline{V}\right)^2\right]=c\bar{I}\overline{V}+c^2v_1\operatorname{var}(I_t)+c^2v_1^2\left[E\left[I_t-\bar{I}\right]^3-\overline{K}\operatorname{var}(I_t)\right] \tag{17}$$

where the two series r_t and $\hat{V}_t$ are the return series and the detrended volume series, respectively. I_t is the information intensity variable. $\bar{r}$ is the constant representing the possibility of a nonzero mean return. c is a positive constant that reveals the changed detrending volume. The most important parameters, v_0 and v_1, are the noise and informed components of volume, respectively.

From Equation (6) to Equation (17), aside from the observed volume and returns, there are still nine free parameters that need to be estimated by applying the GMM procedure of Hansen (1982). The parameter vector is given by:

$$(\bar{r},E\left[I_t^{1/2}\right],\bar{I},E\left[I_t^{3/2}\right],\operatorname{var}(I_t),E\left[I_t-\bar{I}\right]^3,v_0,v_1,c) \tag{18}$$

Using twelve orthogonality conditions to estimate the nine free parameters results in three over-identifying restrictions. Hence, the chi-squared distribution with three degrees of freedom (χ_3^2) is suitable for the test of goodness-of-fit. If the test statistics are above the critical value, there is no evidence to support the MDH. Conversely, if the test statistics are smaller than the critical value, the MDH holds.

By examining the estimated values of v_0 and v_1, the relative impact of the noise and informed components of volume can be identified. The estimated values reveal what types of trade dominate the market. If the stock market is destabilized, the noise component of volume must be larger than the informed component. Aside from the two crucial parameters, the MDH are composed of the other seven parameters. $\bar{r}$ is the expected return of the stock. As the average daily indicator of information, $\bar{I}$ may be high or low but it cannot be negative. $\mathrm{var}(I_t)$ represents the variation of the information intensity. $E\left[I_t^{1/2}\right]$ and $E\left[I_t^{3/2}\right]$ reflect the other moments of the information process and are expected to be positive. $E\left[I_t - \bar{I}\right]^3$ is the parameter representing whether information intensity is distributed symmetrically around its mean or whether it is skewed.

4. Empirical results

The estimated coefficients of r_{t-1}^2 and h_{t-1} (i.e. β and γ) in Equation (1) for the ten stocks in the Badla period, transition period, and post-introduction period are reported in Table 6. The report of α is omitted due to its exceedingly small value and relative insignificance.

The statistics for β and γ for the three cases: Badla period vs. transition period, transition period vs. post-introduction period, and Badla period vs. post-introduction period, were computed. Table 6 displays the results. From Table 7, we found that γ was significantly different between the Badla and transition periods and β was significantly different between the transition and post-introduction periods, while both β and γ were not significantly different between the Badla period and the post-introduction period. That is, the volatility of the spot market changes may be due to the Badla mechanism or the introduction of the SSF. We suggest that Badla and the introduction of SSFs may have a similar impact on their underlying stock markets. This indirect evidence demonstrates that India's active single stock futures market might be related to its unique conventional Badla mechanism.

In order to examine which is the main trading force in the cash and derivatives market, we introduced Andersen's (1996) method to deduce the implications of the modified MDH. The results of the GMM test of the stock market are presented in Table 8. The results of the GMM test of the SSFs market are presented in Table 9.

From Table 8, we can see that the statistics of the χ_3^2-test are all above the critical value, which shows that the ten underlyings of the SSF contracts reject the MDH. Also, v_0 is larger than v_1 in the ten stocks for the three periods. This suggests that noise traders are the major driving force in the spot market, corresponding to Anderson's (1996) findings in the U.S. stock market between 1973 and 1991.

The other parameters are almost statistical significantly. The mean return, $\bar{r}$, is an approximation to the descriptive statistics. $E\left[I_t^{1/2}\right]$ and $E\left[I_t^{3/2}\right]$, are all positive as the specification. c is a positive scaling parameter for volume. $\mathrm{var}\left(I_t\right)$ is the variance of the information intensity. Roughly speaking, the estimated value of

$\mathrm{var}(I_t)$ is positive and smaller than the mean information intensity, $\bar{I}$. This implies that the information flows arrive in a regular path. $E[I_t - \bar{I}]^3$ is almost negative. The stocks have an unsymmetrical distribution of information. $\bar{I}$ is positive for all contracts since it is impossible for the information intensity to be negative. These small figures show that not only does information arrive infrequently, but it also has little influence.

In Table 9, similar results can be seen for the SSF market. We claim that all of the ten SSF contracts reject the MDH, since the statistics of the χ_3^2-test are all above the critical value. In addition, we can see that v_0 is larger than v_1 in the ten SSFs. The evidence from both sources suggests that noise traders are the major driving force in the SSF market.

The other parameters are almost statistical significantly. From the observation that the estimated value of $\mathrm{var}(I_t)$ is positive and smaller than the mean information intensity, $\bar{I}$, we claim that the information flows arrive in a regular path. In addition, the SSFs have an unsymmetrical distribution of information, since $E[I_t - \bar{I}]^3$ is almost negative. The small positive figures of $\bar{I}$ show that not only does information arrive infrequently, but it also has little influence.

To compare the extent of noise trading in the spot market during the three sub-periods with that in the SSF market, we compute the ratio of the noise to total volume, which is shown in Table 10. From this table, we can see that after the prohibition against the Badla, noise trading went down in three securities. Berkman and Eleswarapu (1998) reported that when Badla trading on the BSE was banned between 1993 and 1995, noise trading declined. Later, after the introduction of the

SSFs, noise trading went up in seven securities. For four securities among the seven, noise trading during the post-introduction period was even worse than it was during the Badla period. Noise trading dominates informed trading in the SSF market, for the ratio stands at a very high level, from 0.8 to 0.95.

To sum up, our analysis supports the hypothesis that uninformed market participants, attracted to the SSF market due to low transaction costs and high leverage, introduce variability into the prices of both derivative and cash markets. Our findings stand against the viewpoint that derivatives lure additional informed traders to improve the transmission of news and to create a more efficient impounding of information on prices. On the contrary, based on our findings, we believe that increases in volatility may be viewed as an undesirable consequence of the introduction of derivatives. We suspect that in the absence of the price discovery function of futures, trading in the SSF market is probably much like trading in a casino.

5. Conclusion

In this paper, we used data obtained from the National Stock Exchange (NSE) of India to determine whether the Badla trading mechanism and the introduction of SSF contracts had influenced the volatility of underlying stock returns in a similar way. We began by employing the GARCH (1,1) model suggested by Akgiray (1989) and the statistic suggested by Harnett and Soni (1991) to determine whether there was a structural change in the volatility of underlying stock returns before and after the ban of Badla, and before and after the introduction of the SSF contracts. We conclude that, within our research samples, the volatility of the spot market changes may be due to the Badla mechanism or the introduction of the SSF. We also suggest that Badla and the introduction of SSFs may have a similar impact on their underlying stock markets.

However, we also found that noise traders are the major driving force behind the NSE's spot market as well as its futures market. By employing Andersen's (1996) method, we found evidence to support the rejection of the modified Mixture of Distribution Hypothesis (MDH). This implies that the introduction of SSFs could destabilize the cash market as well as the futures market, resulting in undesirable consequences. Once the price discovery function of futures fails to perform, trading in the SSFs market is inevitably somewhat like trading in a casino. We suspect that the NSE's bustling SSFs market is made up of a great majority of investors with gambling spirits.

By comparing the newly invented futures contracts to the conventional transaction mechanism of Badla, we offer a new insight into India's SSFs market. We suggest that India's active single stock futures market might be related to its unique Badla mechanism. Not only do SSFs share some properties with the Badla, they have also inherited their trading climate from Badla. For other exchanges around the world eager to introduce SSFs due to the temptation of high profits or running a business such as the NSE, we advise that they should look before they leap. For India's policy-makers, the enforcement of stricter market regulations may be warranted.

References

Akgiray, V. (1989), 'Conditional heteroskedasticity in time series of stock returns: evidence and forecasts,' *Journal of Business*, 62, 55–80.

Andersen, T. G. (1996), 'Return volatility and trading volume: An information flow interpretation of stochastic volatility,' *Journal of Finance*, 51, 169-204.

Antoniou, A., and P. Holmes (1995), 'Futures trading, information and spot price volatility: Evidence for the FTSE-100 stock index futures contract using GARCH,' *Journal of Banking and Finance*, 19, 117–129.

Antoniou, A., P. Holmes, and R. Priestley (1998), 'The effects of stock index futures trading on stock index volatility: An analysis of the asymmetric response of volatility to news,' *Journal of Futures Markets*, 18, 151–166.

Antonious, A., and H. Phil, (1995), 'Futures trading, information and spot price volatility: Evidence for the FTSE-100 stock index futures contract using GARCH,' *Journal of Banking and Finance*, 19,117–129.

Back, K. (1993), 'Asymmetric information and options,' *The Review of Financial Studies*, 6, 435-472.

Bae, S. C., T. H. Kwon, and J. W. Park (2004), 'Futures trading, spot market volatility, and market efficiency: The case of the Korean index futures markets,' *Journal of Futures Markets*, 24, 1195-1228.

Berkman, H. and V. R. Eleswarapu (1998), 'Short-term traders and liquidity: a test using Bombay Stock Exchange data,' Journal of Financial Economics, 47, 339-355.

Bessembinder, H. and P. J. Seguin (1992), 'Futures trading activity and stock price volatility,' *Journal of Finance*, 47, 2015–2034.

Bessembinder, H. and P. J. Seguin (1993), 'Price volatility, trading volume, and market depth: Evidence from futures,' *Journal of Financial and Quantitative Analysis*, 28, 1, 21–39.

Brown-Hruska, S. and G. Kuserk (1995), 'Volatility, volume, and the notion of balance in the S&P 500 cash and futures market,' *Journal of Futures Markets*, 15, 677–689

Chang, E., Ray Y. Chou, and Edward. F. Nelling (2000), 'Market volatility and the demand for hedging in stock index futures,' *Journal of Futures Markets*, 20, 105–125

Chatrath A., S. Ramchander, F. Song (1996), 'The role of futures trading activity in exchange rate volatility,' *Journal of Futures Markets*, 16, 561-584

Chau, F., P. Holmes, and K, Paudyal (2005), 'The impact of single stock futures on feedback trading and the market dynamics of the cash market,' *University of Durham Working paper*.

Chen, N. F., C. J. Cuny, and R. A. Haugen (1995), 'Stock volatility and the levels of the basis and open interest in futures contracts,' *Journal of Finance*,50, 281–300.

Choi, H. and A. Subrahmanyam (1994), 'Using intraday data to test for effects of index futures on the underlying markets,' *Journal of Futures Markets*, 14, 293–322.

Chou, Ray Y., J. H. Lee, and C.C. Wu (2002), 'The effect of futures introduction on market volatility and information transmission,' *Journal of Financial Studies*, 10, 1–22.

Conrad, J. (1989), 'The price effect of option introduction,' *Journal of Finance*, 44, 487 – 498

Cox, C. C. (1976), 'Futures trading and market information,' *Journal of Political*

Economy, 84, 1215–1237.

Darrat, A. F., S. Rahman, and M. Zhong (2002), 'On the role of futures trading in spot market fluctuations: Perpetrator of volatility or victim of regret?' *Journal of Financial Research*, 25, 431–444.

Dennis S. A., and A. B. Sim (1999), 'Share price volatility with the introduction of individual share futures on the Sydney Futures Exchange,' *International Review of Financial Analysis*, 8, 153-163.

Easley, D., M. O'Hara, and P. S. Srinivas, (1998), 'Option volume and stock prices: Evidence on where informed traders trade,' *Journal of Finance*, 53,431-465.

Epps, T. W., and M. L. Epps (1976), 'The stochastic dependence of security price changes and transaction volumes: Implications for the mixture-of-distributions hypothesis,' *Econometrica*, 44, 305-321

Figlewski S. (1981), 'Futures Trading and Volatility in the GNMA Market,' *Journal of Finance*, 36, 445–456.

Glosten, L., R., Jagannathan, and D., Runkle (1989), 'Relationship between the Expected Value and the Volatility of the Nominal Excess Return on Stocks,' *Working Paper*, Department of Finance, Columbia University.

Gulen, H., and S. Mayhew (2000), 'Stock index futures trading and volatility in international stock market,' *Journal of Futures Markets*, 20, 661–685.

Harnett, D. L., and A. K. Soni (1991), 'Statistical methods for Business and economics,' 4th edition, Addison-Wesley, Reading, MA.

Holmes, P., and M. Tomsett (2004), 'Information and noise in U.K. futures markets,' *Journal of Futures Markets*, 24, 711-731.

Holmes, P., and Rougier, J. (2005), 'Trading volume and contract rollover in futures contracts,' *Journal of Empirical Finance*, 12, 317-338.

Hung, M. W., C. F. Lee and L. C. So(2000), 'Impact of foreign-listed single stock futures on the domestic underlying stock markets,' *Applied Economics Letters*, 10, 567–574.

Illueca, M., and J. A. Lafuente (2003), 'The effect of spot and futures trading on stock index market volatility: A nonparametric approach,' *The Journal of Futures Markets*, 23, 841-858

John, R. M. (2004), 'Presence of conditional heteroscesticity in stock returns: Evidence from NSE, India,' *Working pape*r, Indira Gandhi Institute of Development Research.

Lee, C. I., and H. C. Tong (1998), 'Stock futures: the effects of their trading on the underlying stocks in Australia,' *Journal of Multinational Financial Management*, 8, 285–301.

Lee, S. B., and K. Y. Ohk (1992), '**S**tock index futures listing and structural changes in time-varying volatility,' *Journal of Futures Markets*, 12, 493-509.

Mckenzie, M. D., T. J. Brailsford, and Robert W. Faff (2000), 'New insights into the impact of the introduction of futures trading on stock price volatility,' *Journal of Futures Markets*, 21, 237–255

Mohan, G., S. Kumar, and S. Pappu (2002), 'Understanding volatility: The case of the introduction of futures trading in the National Stock Exchange, India,' *Working paper*, Indian Institute of Management, Ahmedabad.

Newey, W. K., and K. D. West (1987), "A simple, positive semi-definite, heteroskedasticity consistent covariance matrix", *Econometrica* , 703-708.

Pericli A., and G. Koutmos (1997), 'Index futures and options and stock market volatility,' *Journal of Futures Markets*, 17, 957-974

Rahman, S. (2001), 'The introduction of derivatives on the Dow Jones Industrial Average and their impact on the volatility of component stocks,' *Journal of Futures Markets*, 21, 633–653.

Rougier, J. (1996), 'An optimal price index for stock index futures contracts,' *Journal of Futures Markets*, 16, 189-199.

Shastri, K., R. S. Thirumalai, and C. J. Zutter (2008), 'Information revelation in the futures market: Evidence from Single Stock Futures,' *Journal of Futures Markets*, 28, 335–353.

Spyrou, S. I. (2005), 'Index futures trading and spot market volatility evidence from an emerging market,' *Journal of Emerging Market Finance*, 4, 151-167.

Tauchen, G. E., and M. Pitts (1983), 'The price variability-volume relationship on speculative markets,' *Econometrica*, 51, 485-505.

Weaver R. D., and A. Banerjee (1990), 'Does futures trading destabilize cash prices? Evidence for U.S. live beef cattle,' *Journal of Futures Markets*, 10, 1041–1060.

Yang, J., R. B. Balyeat, and D. J. Leatham (2005), 'Futures trading activity and commodity cash price volatility,' *Journal of Business Finance and Accounting*, 32, 297–323.

Footnotes

1. Refer to Berkman and Eleswarapu (1998) for more details about the Badla trading system on the BSE.

2. Under the Badla, trades occur on all working days but settle only once a week. Suppose a person buys 1000 shares on the first day of the settlement period and then sells 500 shares on the next day. The net open position of 500 shares leads to settlement. However, under the T+5 rolling settlement, his 1000 shares long position and 500 shares short position will be settled separately on five working days after the trading dates.

3. The term 'Mixture of Distribution Hypothesis (MDH)' comes from Tauchen and Pitts (1983), and states that, with information arrival, both daily price change and trading volumes are mixtures of independent normals.

4. Only Syndicate Bank has fewer observations from December 27, 1999 to May 31, 2005.

5. The daily prices of single stock futures are calculated from the closing price by the method of Rougier's (1996) contiguous price index. Then, return series are presented in logarithm format.

6. To construct the detrended volume, we divided the actual trading volume by the value calculated from a nonparametric kernel regression with a normal kernel.

7. The assumption of a conditional Poisson rather than normal distribution makes the modified MDH different from the standard MDH (see Anderson, 1996).

Table 1

The world rankings of SSF contracts by volume traded and notional value

		Volume		Value(USD million)	
Nation	**Exchange**	**2005**	**2004**	**2005**	**2004**
India	National Stock Exchange	1	1	1	1
Russia	RTS Stock Exchange	2	2	2	2
South Africa	Johannesburg Stock Exchange	3	5	6	8
Spain	BME Spanish Exchange	4	4	5	4
United Kingdom	Euronext Liffe	5	3	3	3
Italy	Borsa Ilaliana	6	7	4	5
Sweden and Finland	OMX	7	6	NA	NA
Greek	Athens Stock Exchange	8	8	9	7
Hungary	Budapest Stock Exchange	9	9	7	6
Australia	Australian Stock Exchange	10	10	8	9

Note: NA means "Not Available".

Sources: World Federation of Exchanges (http://www.world-exchanges.org/WFE/home.Asp)
RTS Stock Exchange (http://www.rts.ru/?tid=541)

Table 2

A comparison of Badla and Futures

Badla	Futures
♦ Expiration date unclear	♦ Expiration date known
♦ Spot market and different expiration dates are mixed up	♦ Spot market and different expiration dates all trade distinct from each other.
♦ Identity of counterparty often known	♦ Clearing corporation. is counterparty
♦ Counterparty risk present	♦ No counterparty risk
♦ Badla financing is additional source of risk	♦ No additional risk.
♦ Badla financing contains default-risk premium	♦ Financing cost at close to riskless thanks to counterparty guarantee
♦ Asymmetry between long and short	♦ Long and short are symmetric
♦ Position can break down if borrowing / lending proves infeasible	♦ You can hold till expiration date for sure, if you want to

Sources: National Stock Exchange of India Limit. (http://www.nseindia.com)

Table 3

The dates and observations for the ten stocks in National Stock Exchange of India

Name(Symbol)	Data period	Banned date	Introduction date	Badla period	Transition period	Introduction period	Total observations
ACC	1999/04/01~2005/05/31	2001/07/02	2001/11/09	567	90	895	1552
BANKINDIA	1999/04/01~2005/05/31	2001/07/02	2003/08/29	567	540	445	1552
ICICIBANK	1999/04/01~2005/05/31	2001/07/02	2003/01/31	567	396	589	1552
INFOSYSTCH	1999/04/01~2005/05/31	2001/07/02	2001/11/09	567	90	895	1552
IPCL	1999/04/01~2005/05/31	2001/07/02	2003/01/31	567	396	589	1552
ONGC	1999/04/01~2005/05/31	2001/07/02	2003/01/31	567	396	589	1552
RELIANCE	1999/04/01~2005/05/31	2001/07/02	2001/11/09	567	90	895	1552
SATYAMCOMP	1999/04/01~2005/05/31	2001/07/02	2001/11/09	567	90	895	1552
SBIN	1999/04/01~2005/05/31	2001/07/02	2001/11/09	567	90	895	1552
SYNDIBANK	1999/12/27~2005/05/31	2001/07/02	2003/09/26	379	560	425	1364

Table 4

Average trading volume for the sub-set of all samples

Name(Symbol)	Average Trading Volume (million shares)			
	Badla period	Transition period	Post-introduction period	SSFs
ACC	2.93	1.49	1.70	3.74
BANKINDIA	0.147	0.687	2.29	5.06
ICICIBANK	0.177	0.358	1.26	1.89
INFOSYSTCH	0.373.	0.623	0.785.	0.730
IPCL	0.638	0.867	1.55.	3.06
ONGC	0.034138	0.240	1.36.	1.71
RELIANCE	7.09	3.28	4.97.	5.94
SATYAMCOMP	7.08	9.30	11.2	10.5
SBIN	2.90	0.293	2.73	4.65
SYNDIBANK	0.179	0.827	1.55	5.73

Table 5

Mean and variance for the sub-set of all samples

	Return series					
	Badla period		Transition period		Post-introduction period	
Name(Symbol)	Mean	Variance	Mean	Variance	Mean	Variance
ACC	-0.004207	0.011106	0.000724	0.000968	0.001061	0.000440
BANKINDIA	-0.000568	0.000103	0.002390	0.000683	0.001467	0.001247
ICICIBANK	0.002753	0.001840	0.000405	0.000899	0.001670	0.001156
INFOSYSTCH	0.000488	0.002514	-0.002979	0.002794	-0.000271	0.002784
IPCL	-0.001323	0.001352	0.001514	0.001013	0.001013	0.00107
ONGC	0.000475	0.001005	0.002220	0.000767	0.00094	0.000881
RELIANCE	0.001823	0.000873	-0.003845	0.000908	0.000803	0.000380
SATYAMCOMP	-0.004059	0.007481	-0.001637	0.002344	0.001256	0.000895
SBIN	0.0000838	0.000910	-0.000896	0.000578	0.001351	0.000477
SYNDIBANK	-0.000956	0.000634	0.001965	0.000699	0.001353	0.000477

Table 6

Estimates from the variance equation for different periods $\sigma_t^2 = \alpha + \beta\varepsilon_{t-1}^2 + \gamma\sigma_{t-1}^2$

	Badla period				Transition period				Post-introduction period			
	β		γ		β		γ		β		γ	
Name(Symbol)	**coefficient**	P-value	**coefficient**	P-value	**coefficient**	P-value	**coefficient**	P-value	**coefficient**	P-value	**coefficient**	P-value
ACC	**1.964630***	0.0000	**0.643378***	0.0000	**0.273351***	0.0201	**0.549412***	0.0001	**0.100668***	0.0000	**0.873798***	0.0000
BANKINDIA	**0.179481***	0.0000	**0.686944***	0.0000	**0.192381***	0.0000	**0.788373***	0.0000	**0.340856***	0.0000	**0.105813**	0.3138
ICICIBANK	**0.128056***	0.0000	**0.838671***	0.0000	**0.268567***	0.0000	**0.534840***	0.0016	**0.185951***	0.0000	**0.379935***	0.0016
INFOSYSTCH	**0.141587***	0.0000	**0.885042***	0.0000	**0.333620**	0.0600	**0.668191***	0.0000	**-0.002321**	0.4814	**0.595677**	0.4023
IPCL	**0.169268***	0.0003	**0.528959***	0.0000	**0.628610***	0.0000	**0.639870***	0.0000	**0.247162***	0.0000	**0.676173***	0.0000
ONGC	**0.078606***	0.0007	**0.878833***	0.0000	**0.334099***	0.0000	**0.619579***	0.0000	**0.125547***	0.0000	**0.867042***	0.0000
RELIANCE	**0.155834***	0.0000	**0.778341***	0.0000	**0.697527***	0.0020	**0.348854***	0.0085	**0.239802***	0.0000	**0.409531***	0.0000
SATYAMCOMP	**1.469144***	0.0000	**-0.000826**	0.92270	**0.253519***	0.0296	**-0.775888***	0.0002	**0.102397***	0.0000	**0.855541***	0.0000
SBIN	**0.057002***	0.0027	**0.909136***	0.0000	**0.434712***	0.0350	**0.499154**	0.1405	**0.096547***	0.0000	**0.882723***	0.0000
SYNDIBANK	**-0.023637***	0.0000	**1.002670***	0.0000	**0.243152***	0.0000	**0.792219***	0.0000	**0.305393***	0.0001	**0.527634***	0.0000

Notes: Figures marked with* are expected statistically significant at the 5% level.

Table 7

The statistic t^* for β and γ

Periods(Pre/Post)	β	γ
Badla period / Transition period	0.293884	1.456725*
Transition period /Post-introduction period	3.0049**	-0.90514
Badla period / Post-introduction period	1.167471	0.79011

Notes: 1. Figures marked with** are statistically significant at the 5% level (t (18) =1.734).

2. Figures marked with* are statistically significant at the 10% level (t (18) =1.330).

3. $$t^* = \frac{(\bar{x}_{pre} - \bar{x}_{post}) - (\mu_{pre} - \mu_{post})}{\sqrt{\frac{((n_{pre}-1)\hat{\sigma}^2_{pre} + (n_{post}-1)\hat{\sigma}^2_{post})}{n_{pre}+n_{post}-1} \cdot (\frac{1}{n_{pre}} + \frac{1}{n_{post}})}}$$, β and γ are calculated by the equation above.

Table 8
GMM estimation results for the Modified Mixture of Distributions Hypothesis in the stock market

$$R_t | I_t \sim N(\bar{r}, I_t) \qquad \hat{V}_t | I_t \sim c \cdot Po(v_0 + v_1 I_t)$$

Panel A: Badla Period										
Name(Symbol)	$\bar{r}$	$E[I_t^{1/2}]$	$\bar{I}$	$E[I_t^{3/2}]$	$Var[I_t]$	$E[I_t - \bar{I}]^3$	C	v_0	v_1	χ_3^2
ACC	-0.001592* (0.0005)	0.039022* (0.0000)	0.008724* (0.0000)	0.014014* (0.0000)	0.013535* (0.0000)	0.207029* (0.0000)	0.320638* (0.0000)	3.186385* (0.0000)	0.287780* (0.0000)	41.8064 (4.41E-09)
BANKINDIA	0.001064 (0.1142)	0.030905* (0.0000)	0.000813* (0.0000)	0.000668* (0.0000)	1.45E-05* (0.0000)	0.001537* (0.0000)	1.035083* (0.0000)	2.142224* (0.0000)	1.115021* (0.0000)	71.8928 (1.66E-15)
ICICIBANK	-0.001213* (0.3354)	0.025736* (0.0000)	0.015376* (0.0000)	0.003567* (0.0000)	0.089716* (0.0000)	-1.929618 (0.0001)	0.062411* (0.0000)	14.57650* (0.0000)	7.790382* (0.0000)	44.4642 (1.20E-09)
INFOSYSTCH	0.001062* (0.0000)	0.033124* (0.0000)	0.001981* (0.0000)	0.001187* (0.0000)	7.49E-05* (0.0000)	-0.010107* (0.0000)	0.199993* (0.0000)	4.816366* (0.0000)	0.768991* (0.0000)	28.0884 (3.61E-06)
IPCL	0.036236* (0.0000)	0.008673* (0.0000)	0.095990* (0.0000)	0.010695* (0.0000)	0.248951* (0.0000)	0.548896* (0.0001)	0.699245* (0.0000)	4.526568* (0.0000)	1.333026* (0.0000)	97.8508 (0.0000)
ONGC	0.002697* (0.0153)	0.018982* (0.0000)	0.001120* (0.0000)	0.005644* (0.0000)	3.51E-05* (0.0000)	-0.047957* (0.0001)	0.688592* (0.0000)	2.831203* (0.0000)	1.278290* (0.0000)	60.3611 (4.92E-13)
RELIANCE	0.003912* (0.0000)	0.021297* (0.0000)	0.000831* (0.0000)	0.001864* (0.0000)	1.18E-05* (0.0000)	-1.009971* (0.0000)	0.280444* (0.0000)	2.756659* (0.0000)	1.296476* (0.0000)	43.3684 (2.05E-09)
SATYAMCOMP	-0.000538 (0.7689)	0.050477* (0.0000)	0.004340* (0.0000)	0.001234* (0.0101)	0.000839* (0.0000)	1.369401 (0.0713)	0.152945* (0.0002)	6.063425* (0.0003)	0.231143* (0.0000)	14.5259 (0.0022)
SBIN	0.002864* (0.0011)	0.021774* (0.0000)	0.000915* (0.0000)	0.001923* (0.0000)	1.37E-05* (0.0000)	-0.001321* (0.1104)	0.750627* (0.0000)	1.262252* (0.0000)	0.431119* (0.0000)	48.5907 (1.59E-10)
SYNDIBANK	0.001374* (0.0019)	0.018856* (0.0000)	0.063650* (0.0000)	0.000320* (0.0000)	0.217120* (0.0000)	0.578786* (0.0000)	0.414327* (0.0000)	6.071716* (0.0000)	0.933592* (0.0000)	38.57719 (2.13E-08)

Notes: 1. Figures in parentheses are p-values. 2. Figures marked with* are statistically significant at the 5% level.

Table 8 (continued)
GMM estimation results for the Modified Mixture of Distributions Hypothesis in the stock market

$$R_t|I_t \sim N(\bar{r}, I_t) \qquad \hat{V}_t|I_t \sim c \cdot Po(v_0 + v_1 I_t)$$

Panel B: Transition Period

Name(Symbol)	$\bar{r}$	$E[I_t^{1/2}]$	$\bar{I}$	$E[I_t^{3/2}]$	$Var[I_t]$	$E[I_t - \bar{I}]^3$	C	v_0	v_1	χ_3^2
ACC	0.004072* (0.0000)	0.024523* (0.0000)	0.001015* (0.0000)	0.000885* (0.0000)	5.40E-06* (0.0000)	-0.002479* (0.0000)	0.898338* (0.0000)	1.215040* (0.0000)	0.398070* (0.0000)	26.0009 (9.53E-06)
BANKINDIA	0.009393* (0.000)	0.016573* (0.0000)	0.001183* (0.0000)	0.001212* (0.0000)	0.000128 (0.0000)	-0.138266 (0.1715)	0.600430* (0.0000)	2.548302* (0.0000)	0.184146* (0.0000)	45.3718 (7.71E10)
ICICIBANK	0.003114 (0.0000)	0.021694* (0.0000)	0.000758* (0.0000)	0.001324* (0.0000)	3.65E-06* (0.0000)	0.001556* (0.0000)	0.876317* (0.0000)	1.842058* (0.0000)	0.952552* (0.0022)	27.1150 (5.56E-06)
INFOSYSTCH	0.00967 (0.3892)	0.038057* (0.0000)	0.002525* (0.0000)	0.000353* (0.0005)	5.30E-05* (0.0164)	-0.835511* (0.0054)	0.046241* (0.0000)	13.34545* (0.0000)	1.123446* (0.0404)	15.3577 (0.0015)
IPCL	0.004628* (0.0000)	0.014303* (0.0000)	0.001478* (0.0000)	0.004636* (0.0000)	5.54E-05* (0.0000)	-0.024045* (0.0000)	1.711381* (0.0000)	1.100196* (0.0000)	0.794438* (0.0000)	35.2349 (1.08E-07)
ONGC	0.001749* (0.0001)	0.008420* (0.0000)	0.000481* (0.0000)	0.012295* (0.0000)	1.22E-05* (0.0000)	-3.419863* (0.0000)	2.183955* (0.0000)	1.361508* (0.0000)	0.401871* (0.0000)	27.2391 (5.24E-06)
RELIANCE	-0.001508 (0.4082)	0.019341* (0.0000)	0.001136* (0.0000)	0.001807* (0.0000)	2.07E-05* (0.0000)	-0.141056* (0.0004)	0.867647* (0.0000)	1.247079* (0.0000)	0.552446* (0.0000)	20.2315 (0.0001)
SATYAMCOMP	-0.001458 (0.4702)	0.044363* (0.0000)	0.004371* (0.0000)	0.000354* (0.0000)	0.000672* (0.0000)	-5.524579* (0.0219)	0.043589* (0.0000)	10.48082* (0.0000)	0.375933* (0.0000)	16.1010 (0.0010)
SBIN	-0.000717 (0.6116)	0.018536* (0.0000)	0.000442* (0.0000)	6.14E-06* (0.0000)	1.60E-06* (0.0000)	-0.001977 (0.5701)	0.304075* (0.0000)	1.222238* (0.0000)	0.152006* (0.0000)	19.6905 (0.0001)
SYNDIBANK	0.006406* (0.0000)	0.012634* (0.0000)	0.000628* (0.0000)	0.002558* (0.0000)	4.19E-05* (0.0000)	-3.340818* (0.0064)	0.730189* (0.0000)	1.767846* (0.0000)	1.404882* (0.0000)	50.8546 (5.23E-11)

Notes: 1. Figures in parentheses are p-values. 2. Figures marked with* are statistically significant at the 5% level.

Table 8 (continued)
GMM estimation results for the Modified Mixture of Distributions Hypothesis in the stock market

$$R_t|I_t \sim N(\bar{r}, I_t) \qquad \hat{V}_t|I_t \sim c \cdot Po(v_0 + v_1 I_t)$$

Panel C: Post-introduction Period

Name(Symbol)	$\bar{r}$	$E[I_t^{1/2}]$	$\bar{I}$	$E[I_t^{3/2}]$	$Var[I_t]$	$E[I_t - \bar{I}]^3$	C	v_0	v_1	χ_3^2
ACC	0.001967* (0.0000)	0.017138* (0.0000)	0.000438* (0.0000)	0.000326* (0.0000)	2.63E-06 (0.0000)	-0.002291* (0.0000)	0.637790* (0.0000)	1.573160* (0.0000)	0.305933* (0.0000)	73.6371 (6.66E-16)
BANKINDIA	0.004069* (0.0000)	0.028063* (0.0000)	0.001198* (0.0000)	0.000490* (0.0000)	7.57E-06* (0.0000)	-0.000598 (0.4180)	0.435931 (0.8998)	2.384723* (0.0000)	0.358017* (0.0000)	29.8927 (1.45E-06)
ICICIBANK	0.002856* (0.0006)	0.016562* (0.0000)	0.000589* (0.0000)	0.002801* (0.0000)	6.29E-06* (0.0000)	-1.641680* (0.0180)	0.459543* (0.0000)	2.959347* (0.0000)	0.694628* (0.0000)	57.7755 (1.75E-12)
INFOSYSTCH	-0.000625* (0.0371)	0.021979* (0.0000)	0.002044* (0.0000)	0.001946* (0.0000)	0.000822* (0.0000)	-3.340460* (0.0000)	0.163887* (0.0000)	7.146080* (0.0000)	1.238382* (0.0000)	91.4303 (0.0000)
IPCL	0.001635* (0.0098)	0.020472* (0.0000)	0.000828* (0.0000)	0.000800* (0.0000)	1.97E-06* (0.0000)	-5.358865* (0.0000)	0.498361* (0.0000)	2.733242* (0.0000)	1.603156* (0.0000)	39.1058 (1.64E-08)
ONGC	0.002316* (0.0000)	0.016835* (0.0000)	0.000557* (0.0000)	0.000489* (0.0000)	6.60E-06* (0.0000)	0.004021* (0.0178)	0.520510* (0.0000)	1.728377* (0.0000)	0.319004* (0.0000)	26.5883 (7.18E-06)
RELIANCE	0.000718* (0.0000)	0.016760* (0.0000)	0.000363* (0.0000)	0.001047* (0.0000)	1.49E-06* (0.0000)	-17.73810* (0.0280)	0.246836* (0.0000)	4.877825* (0.0000)	0.837291* (0.0000)	48.5349 (1.63E-10)
SATYAMCOMP	0.001474* (0.0000)	0.018914* (0.0000)	0.000575* (0.0000)	5.74E-06 (0.0555)	0.117507* (0.0028)	-37.69105 (0.8915)	0.117507* (0.0000)	7.666782* (0.0000)	0.071935 (0.7951)	38.1341 (2.64E-08)
SBIN	0.001261* (0.0000)	0.009905* (0.0000)	0.000541* (0.0000)	0.004066* (0.0000)	1.33E-05* (0.0000)	-5.516946* (0.0000)	0.694638* (0.0000)	1.889432* (0.0000)	1.650482* (0.0000)	72.2926 (5.39E-12)
SYNDIBANK	0.003215* (0.0092)	0.013094* (0.0000)	0.001330* (0.0000)	0.005393* (0.0000)	8.07E-05* (0.0000)	-0.849271* (0.0000)	0.753582* (0.0000)	1.924355* (0.0000)	1.075279* (0.0000)	38.4527 (2.26E-08)

Notes: 1. Figures in parentheses are p-values. 2. Figures marked with* are statistically significant at the 5% level.

Table 9
GMM estimation results for the Modified Mixture of Distributions Hypothesis in the single stock futures market

$$R_t|I_t \sim N(\bar{r}, I_t) \qquad \hat{V}_t|I_t \sim c \cdot Po(v_0 + v_1 I_t)$$

Single Stock Futures Period										
Name(Symbol)	$\bar{r}$	$E[I_t^{1/2}]$	$\bar{I}$	$E[I_t^{3/2}]$	$Var[I_t]$	$E[I_t - \bar{I}]^3$	C	v_0	v_1	χ^2_3
ACC	0.001630* (0.0011)	0.017802* (0.0000)	0.000411* (0.0000)	7.70E-05* (0.0000)	7.67E-07 (0.0000)	-0.001468* (0.0000)	0.321174* (0.0000)	3.101524* (0.0000)	0.244890* (0.0000)	47.6205 (2.56E-10)
BANKINDIA	0.002161* (0.0000)	0.027284* (0.0000)	0.001086* (0.0000)	0.000389* (0.0000)	5.14E-06* (0.0007)	-0.013347* (0.0006)	0.485960* (0.0000)	1.960000* (0.0000)	0.282725* (0.0000)	25.6178 (1.14E-05)
ICICIBANK	0.003236* (0.0000)	0.015281* (0.0000)	0.000470* (0.0000)	0.000692* (0.0052)	6.65E-06* (0.0000)	0.005892* (0.0000)	0.838800* (0.0000)	1.234298* (0.0000)	0.316297* (0.0000)	48.7685 (1.46E-10)
INFOSYSTCH	0.000605 (0.3357)	0.019043* (0.0000)	0.001507* (0.0000)	0.001079* (0.0000)	0.000451* (0.0000)	-0.019770* (0.0002)	0.704313* (0.0000)	1.414369* (0.0000)	0.151339* (0.0000)	69.3218 (5.99E-15)
IPCL	0.000432 (0.5817)	0.021375* (0.0000)	0.000788* (0.0000)	0.000272* (0.0000)	6.39E-06* (0.0000)	-0.008237* (0.0000)	0.435198* (0.0000)	2.344855* (0.0000)	0.243088* (0.0000)	35.7508 (8.45E-08)
ONGC	0.002221* (0.0011)	0.017405* (0.0000)	0.000493* (0.0000)	0.000193* (0.0000)	2.67E-06* (0.0000)	0.003973 (0.2288)	0.396771* (0.0000)	2.668987* (0.0000)	0.247848* (0.0000)	24.8839 (1.63E-05)
RELIANCE	0.001585* (0.0078)	0.016872* (0.0000)	0.000330* (0.0000)	4.80E-05* (0.0000)	6.64E-07* (0.0000)	-0.007064* (0.0065)	0.258966* (0.0000)	3.832133* (0.0000)	0.186673* (0.0000)	31.3915 (7.03E-07)
SATYAMCOMP	0.001379* (0.0380)	0.023687* (0.0000)	0.000656* (0.0000)	0.000273* (0.0000)	7.32E-06* (0.0000)	-21.12903* (0.0000)	0.119515* (0.0000)	8.346382* (0.0000)	2.253586* (0.0000)	67.1639 (1.73E-14)
SBIN	0.002482* (0.0000)	0.016110* (0.0000)	0.000420* (0.0000)	0.000440* (0.0000)	3.78E-06* (0.0000)	-0.000413 (0.3213)	0.534376* (0.0000)	1.719873* (0.0000)	0.396774* (0.0000)	34.8118 (1.33E-07)
SYNDIBANK	0.002396* (0.0408)	0.016394* (0.0000)	0.001168* (0.0000)	0.004355* (0.0000)	5.41E-05* (0.0000)	0.025257 (0.4546)	0.627285* (0.0000)	1.959348* (0.0000)	0.127373* (0.0417)	24.6448 (1.83E-05)

Notes: 1. Figures in parentheses are p-values. 2. Figures marked with* are statistically significant at the 5% level.

Table 10

The ratio of the noise to total volume for stocks and single stock futures contracts

Name (Symbol)	Badla Period			Transition Period			Post-Introduction Period			SSFs		
	v_0	v_1	$\frac{v_0}{v_0+v_1}$	v_0	v_1	$\frac{v_0}{v_0+v_1}$	v_0	v_1	$\frac{v_0}{v_0+v_1}$	v_0	v_1	$\frac{v_0}{v_0+v_1}$
ACC	3.1863	0.2877	0.9171	1.2150	0.3980	0.7532	1.5731	0.3059	0.8371	3.1015	0.2448	0.9268
BANKINDIA	2.1422	1.1150	0.65768	2.5483	0.1841	0.9326	2.3847	0.3580	0.8694	1.9600	0.2827	0.8739
ICICIBANK	14.5765	7.7903	0.6517	1.8420	0.9525	0.6591	2.9593	0.6946	0.8098	1.2342	0.3162	0.7960
INFOSYSTCH	4.0371	1.5368	0.7242	13.3454	1.1234	0.9223	7.1460	1.2383	0.8523	1.4143	0.1513	0.9033
IPCL	4.5265	1.3330	0.7725	1.1001	0.7944	0.5806	2.7332	1.6031	0.6303	2.3448	0.2430	0.9060
ONGC	2.8312	1.2782	0.6889	1.3615	0.4018	0.7721	1.7283	0.3190	0.8441	2.6689	0.2478	0.9150
RELIANCE	2.7566	1.2964	0.6801	1.2470	0.5524	0.6930	4.8778	0.8372	0.8534	3.8321	0.1866	0.9535
SATYAMCOMP	6.0634	0.2311	0.9632	10.480	0.3759	0.9653	7.6667	0.0719	0.9907	8.3463	2.2535	0.7873
SBIN	1.2622	0.4311	0.7454	1.2222	0.1520	0.8893	1.8894	1.6504	0.5337	1.7198	0.3967	0.8125
SYNDIBANK	6.0717	0.9335	0.8667	1.7678	1.4048	0.5572	1.9243	1.0752	0.6415	1.9593	0.1273	0.9389

Figure 1

Average trading volume for the sub-set of all samples