

Securities and Exchange Board of India



Stock Market Volatility – An International Comparison

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The views expressed in this paper are those of the authors and do not necessarily reflect those of the Securities and Exchange Board of India. We sincerely thank Shri G. N. Bajpai, Chairman, SEBI for his unlimited support and encouragement in conducting research work. But for him, it would not have been possible to bring out this paper timely. We also thank many of our colleagues for their comments and suggestions.

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Foreword

During the past few years Indian Capital Market has undergone metamorphic reforms. Every segment of Indian Capital Market viz primary and secondary markets, derivatives, institutional investment and market intermediation has experienced impact of these changes. Our market, today, is being recognized as one of the most transparent, efficient and clean markets. Several techniques /instruments are used by academicians, policy makers, practitioners and investors to test the extent of efficiency of the market. In this research paper, an attempt has been made to analyse distributional characteristics of stock indices in India and compare them with some of the mature as well as emerging capital markets around the globe. Return (Mean), Volatility (Standard Deviation), Skewness and Kurtosis are computed for various indices for different lengths of periods. These, known as first, second, third and fourth order moments of a distribution respectively, provide a picture of Indian stock price movements.

In the recent past there have been perceptions that volatility in the market has gone up; Inter and Intra-day volatility. News items and some clinical research papers also provided figures to evidence this argument. SEBI undertook a comprehensive and deep analysis of volatility by using several statistical techniques to measure and analyse it. 18 countries covering almost all continents- developed as well as emerging markets and young and old markets- have been analysed. The results show that the volatility has not gone up much in the recent past as it has been perceived. Indian stock market provides a very high rate of return and comparatively moderate volatility. Efficiency of Indian market appear to have improved in the past few years owing to contraction in settlement cycles, introduction of derivative products, improvement in corporate governance practices etc,. Stock market return exhibit informational efficiency and approximates to normal distribution.

I heartily extend my congratulations to the Research Department for bringing out this paper. I also expect it to conduct further study at individual stock level, to find out behaviour of idiosyncratic volatility which will be of great help to various policy makers.

G.N.Bajpai
Chairman
Securities and Exchange Board of India

April 19, 2004
Mumbai

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Securities and Exchange Board of India

The Securities and Exchange Board of India (SEBI) was constituted on 12 April 1988 as a non-statutory body through an Administrative Resolution of the Government for dealing with all matters relating to development and regulation of the securities market and investor protection and to advise the government on all these matters. SEBI was given statutory status and powers through an Ordinance promulgated on January 30 1992. SEBI was established as a statutory body on 21 February 1992. The Ordinance was replaced by an Act of Parliament on 4 April 1992. The preamble of the SEBI Act, 1992 enshrines the objectives of SEBI – to protect the interest of investors in securities market and to promote the development of and to regulate the securities market. The statutory powers and functions of SEBI were strengthened through the promulgation of the Securities Laws (Amendment) Ordinance on 25 January 1995, which was subsequently replaced by an Act of Parliament.

Stock Market Volatility – An International Comparison

M. T. Raju · Anirban Ghosh

Abstract

Volatility estimation is important for several reasons and for different people in the market. Pricing of securities is supposed to be dependent on volatility of each asset. In this paper we not only extend the study period of the earlier paper but also expand coverage in terms of number of countries and statistical techniques. Mature markets / Developed markets continue to provide over long period of time high return with low volatility. Amongst emerging markets except India and China, all other countries exhibited low returns (sometimes negative returns with high volatility). India with long history and China with short history, both provide as high a return as the US and the UK market could provide but the volatility in both countries is higher. The third and fourth order moments exhibit large asymmetry in some of the developed markets. Comparatively, Indian market show less of skewness and Kurtosis. Indian markets have started becoming informationally more efficient. Contrary to the popular perception in the recent past, volatility has not gone up. Intra day volatility is also very much under control and has come down compared to past years.

Stock Market Volatility : An International Comparison

Peripatetic stock prices and their volatility, which have now become endemic features of securities markets add to the concern. The growing linkages of national markets in currency, commodity and stock with world markets and existence of common players, have given volatility a new property – that of its speedy transmissibility across markets.

To many among the general public, the term volatility is simply synonymous with risk: in their view high volatility is to be deplored, because it means that security values are not dependable and the capital markets are not functioning as well as they should. Merton Miller (1991) the winner of the 1990 Nobel Prize in economics - writes in his book *Financial Innovation And Market Volatility* *“By volatility public seems to mean days when large market movements, particularly down moves, occur. These precipitous market wide price drops cannot always be traced to a specific news event. Nor should this lack of smoking gun be seen as in any way anomalous in market for assets like common stock whose value depends on subjective judgement about cash flow and resale prices in highly uncertain future. The public takes a more deterministic view of stock prices; if the market crashes, there must be a specific reason.”*

The issues of volatility and risk have become increasingly important in recent times to financial practitioners, market participants, regulators and researchers. Amongst the main concerns, which are currently expressed include: - has the world's financial system become more volatile in recent times? Has financial deregulation and innovation lead to an increase in financial volatility or has it successfully permitted its redistribution away from risk averse operators to more risk neutral market participants? Is the current wave of financial innovation leading to a complete set of financial markets, which will efficiently distribute risk? Has global financial integration led to faster transmission of volatility and risk across national frontiers? Can financial managers most efficiently manage risk under current circumstances? What role the regulators ought to play in the process? This paper would be useful in debating some/all of these issues.

As a concept, volatility is simple and intuitive. It measures variability or dispersion about a central tendency. To be more meaningful, it is a measure of how far the current price of an asset deviates from its average past prices. Greater this deviation, greater is the volatility. At a more fundamental level, volatility can indicate the strength or conviction behind a price move.

Despite the clear mental image of it, and the quasi-standardised status it holds in the field of finance, there are some subtleties that make volatility challenging to analyse. Since volatility is a standard measure of financial vulnerability, it plays a key role in assessing the risk/return trade-offs and forms an important input in asset allocation decisions. In segmented capital markets, a country's volatility is a critical input in the cost of capital (Bekaert and Harvey 1995). Peters (1994) noted that stock prices and returns are cyclical, imperfectly predictable in the short run,

and unpredictable in the long run and that they exhibit nonlinear, and possibly chaotic, behavior related to time-varying positive feedback.

Asset-return variability can be summarised by statistical distributions. Typically, the normal distribution is used to characterise a series of returns. The distribution is centered at the mean and its width is determined by the standard deviation (volatility). Return series may not be normally distributed and often tend to exhibit excess kurtosis, so that extreme values are more likely than the normal distribution would suggest. Such fat-tailed distributions are common with financial parameters. Skewness is also common, especially with equity returns, where big down-moves are typically more likely than comparable, big up-moves.

Time-variation in market volatility can often be explained by macroeconomic and microstructural factors (*Schwert 1989a,b*). Volatility in national markets is determined by world factors and part determined by local market effects, assuming that the national markets are globally linked. It is also consistent that world factors could have an increased influence on volatility with increased market integration. *Bekaert and Harvey (1995)* showed this using time-varying market integration parameter. Research has also shown that capital market liberalisation policies too, are likely to affect volatility. It would be of interest to policy makers that the correlation between the two has been found to be positive in the case of some countries. This paper does not reexamine any of these issues. Nor does this paper seek to throw an insight into the existence of a possible relationship between such variables which capture financial and economic integration as market capitalisation to GDP, country credit risk ratings.

There are several reasons which prompted us to take up this study once again now. First, perceptions vary about the dispersions of Indian stock prices. Second, there is a need for a comprehensive study on the volatility of Indian stock markets covering as long a period as 20 years along with intra-day volatility (to the extent data is available from a single source) and international comparison.

Third, comparison of time-series volatility of Indian equity market, with other emerging and developed markets, distributional characteristics of the variance process and evidence if any, of asymmetries in volatility under different market conditions (especially for India during pre and post reform) may shed interesting light on the evolving characteristics of Indian equity market.

Finally, at the level of the investor, frequent and wide stock market variations cause uncertainty about the value of an asset and affect the confidence of the investor. Risk averse and risk neutral investors may shy away from the market with frequent and sharp price movements. An understanding of the market volatility is thus important from the regulatory policy perspective.

When the total volatility of individual stock is decomposed into systematic volatility and idiosyncratic volatility, it is clearly evident that idiosyncratic volatility has trended up. Cross-sectional regressions that the volatility of individual stocks maybe related to the amount of institutional ownership. This paper does not make an attempt to measure idiosyncratic volatility both at index as well as at stock levels.

While idiosyncratic volatility can be eliminated in a well-diversified portfolio, individual investors may still care about the specific risk of the securities they hold. Because of wealth constraints or by choice, many investors do not hold diversified portfolios. Those investors

might feel that the risk of their portfolios has increased when idiosyncratic volatility is rising. Moreover, high idiosyncratic volatility could increase potential total transactions costs if investors with relatively limited means choose to achieve adequate diversification. This is so because an increase in idiosyncratic volatility will have an important effect on increasing the number of securities one must hold to achieve reasonably “full” diversification. Idiosyncratic volatility is also important to arbitrageurs and option traders, whose total profits depend on total volatility instead of market volatility.

Although it is important and necessary to understand and estimate volatility of individual stock level, it has not been carried out in this study owing to objectives set and time and space restrictions.

Methodology

Existing studies of volatility across markets, (*Bekaert and Harvey 1995*), have shown that the characteristics of emerging market equities are vastly different from those for developed markets' equities. The emerging market returns in the past have demonstrated certain distinguishing features; average returns were higher, correlation with developed market returns was low, investors looked to emerging markets for risk diversification, returns were more predictable and volatility was higher. Our research focuses particularly on return and volatilities behavior, across markets.

We provide a detailed analysis of equity market volatility in 18 developed and emerging markets, including India. Our research helps understand the time series variation and higher order moments in the volatility of equities in these markets.

We use the International Organisation of Securities Commission (IOSCO) classification to categorise countries into emerging and developed markets. The names of the countries, indices and data periods are provided in the following Exhibit I. There are six countries from developed capital markets and twelve from emerging markets including India. Bloomberg database is used by us as the data source. To some extent our choice and number of countries is limited to availability of data from the Bloomberg Service. As far as India, two popular indices viz., BSE Sensex and S&P CNX Nifty are analysed, while for all other countries single index is used for each country.

EXHIBIT - I

NAMES OF THE COUNTRIES, INDICES AND DATA PERIOD

Country	Index	Period	Observations
USA	S&P 500	80:1 – 03:12	6061
UK	FTSE 100	84:1 – 03:12	4668
France	CAC 40	87:7 – 03:12	4133
Germany	DAX 30 Xetra	80:1 – 03:12	6023
Australia	All Ordinaries	84:1 – 03:12	5076
Hong Kong, China	Hang Seng	81:1 – 03:12	5685
Singapore	Straits Time	85:1 – 03:12	4755
Malaysia	Kuala Lumpur Composite	80:1 – 03:12	5905
Thailand	Stock Exchange of Thailand	87:7 – 03:12	4031
China	Shanghai Composite	95:1 – 03:12	2175
Indonesia	Jakarta Composite	91:11 –03:12	2964
Chile	Chile Stock Market General	91:9 – 03:12	3079
Brazil	IBOV	92:1 – 03:12	2955
Mexico	MEXBOL	92:1 – 03:12	3005
South Africa	JALSH	95:6 – 03:12	2125
Korea	KOSPI	81:4 – 03:12	6373
Taiwan	TWSE	83:10 –03:12	5630
India	BSE Sensex	85:1 – 03:12	4286
India	S&P CNX Nifty	95:1 –03:12	2221

Bloomberg usually chooses the most popular indices to describe the movements in stock prices in the respective markets. Among these indices for each market, we choose the principally recognised stock price index of each country and obtain the time series data for a 24 year period from 1980:1 2003:12. Index series are published in the currency of local markets. For cross-country comparisons, all indices are converted into one common currency, the US dollar, by using a standard conversion method provided in the Bloomberg system. For some countries, the data is not available for the entire period, either as the markets were not fully developed and hence there were no indices or the data had not been captured by Bloomberg. Consequently, the data points are not uniform for all the countries. The analysis and conclusions are not affected by this shortcoming as we study each country separately and on an annual basis.

We use the standard indices with the limitation that the number of stocks in the national index, asset concentration, relative weights, and cross-sectional volatility of individual stocks could have an impact on the results. Despite this limitation, the study would still give a strong insight into the volatility of the markets.

We begin by analysing the time series of volatility. We use standard deviation as a proxy for variability in stock prices. As a first step, we calculate returns using logarithmic method as follows:

$$r_t = \ln \left(\frac{I_t}{I_{t-1}} \right) \quad (1)$$

where r_t and I_t indicate return and index value respectively at time 't'.

Next, arithmetic mean, standard deviation, skewness and excess kurtosis are computed as discussed later. Past cross-country studies have indicated non-normality of stock returns. We therefore, go beyond the first and second order moments, and compute third and fourth order moments to infer more information about the patterns of price returns.

Volatility

We use the following standard formula for computing standard deviation.

$$s = \sqrt{(1/n-1) \sum (r_t - \bar{r})^2} \quad (2)$$

We use Parkinson's (1980) model, which uses intra-day highs and lows, for estimation of intra-day volatility. Since, most asset pricing models are based on continuous time the extreme value estimators are more efficient. We use the following Parkinson model to estimate intra-day volatility. This volatility measure is referred to as high-low volatility in our paper usage of factor 0.601 scales down volatility although, statistically, it is correct. Therefore, in order to provide additional information on intra-day (high-low) volatility we computed it $K = 1$ also.

$$s = k \sqrt{1/n \sum \log(H_t/L_t)^2} \quad (3)$$

where $k = 0.601$ and H_t and L_t denote intra-day high and low respectively.

We also use the above formula i.e.

$$s = k \sqrt{1/n \sum \log(H_t/L_t)^2} \quad (4)$$

with $k = 1$ to measure high-low volatility.

We calculated square root of the average r^2 for each year to capture the absolute changes in volatility and this is called "return squared volatility". Here r is the daily log-normal return and is defined as

$$r_t = \ln(I_t / I_{t-1}) * 100 \quad (5)$$

where I_t is the closing value of the index at time period t .

We calculated daily r^2 and took an average of r^2 for the whole year. We then took the square root of this average r^2 to arrive at the volatility figure.

After calculating the square root of the average r^2 in the method described above we sorted the top 5 percent of the same (i.e. square root of the average r^2) and compared this top 5 percent of the observations of a particular year with the square root of the average r^2 calculated for the whole year.

We use the Garman and Klass (1980) estimator which uses four intra-day variation statistics of open, high, low and close. This volatility measure is referred to as open-close volatility in our paper. The following model is used for this estimator.

$$s = \sqrt{\frac{1}{n} \sum (1/2) [\log(H_t/L_t)]^2 - [2 \log(2) - 1] [\log(C_t/O_t)]^2} \quad (6)$$

where H_t , L_t , C_t , and O_t denote intra-day high, low, close and open respectively.

Skewness

As stated previously, stock returns exhibit non-normality. If the returns are normally distributed, then coefficients of skewness and excess kurtosis should be equal to zero. We use the following model to measure non-normality or asymmetry of equity returns.

$$Sk = \left(n^2 / (n-1)(n-2) \right) \left(m_3 / s^3 \right) \quad (7)$$

where: n = sample size,

 m₃ = third moment about the mean, and

 s = standard deviation

Excess Kurtosis

We measure the excess kurtosis by the following model

$$Ku = \left[n^2 / (n-1)(n-2)(n-3) \right] \left\{ (n+1)m_4 - 3(n+1)m_2^2 \right\} / s^4 \quad (8)$$

where n = sample size

 m₄ = fourth moment about the mean,

 m₂ = second moment about the mean, and

 s = standard deviation

A comparison of a normal distribution with a distribution exhibiting positive excess kurtosis reveals the following points. For example, two distributions have the same mean and variance, but the positive excess kurtosis distribution is more peaked and has fatter tails. It is very interesting to note what happens when we move from a normal distribution to a distribution with positive excess kurtosis. Probability mass is added to the central part of the distribution and to the tails of the distribution. At the same time, probability mass is taken from regions of the probability distribution that are intermediate between the tails and the centre. The effect of excess kurtosis is therefore to increase the probability of very large moves and very small moves in the value of the variable, while decreasing the probability of moderate moves.

Analysis of Results

Table 1 provides details of daily mean return and daily standard deviations for the sample countries over 24 year period from 1980 to 2003. For certain countries, the starting year is not 1980 owing to non-availability of data for various reasons that include :

- a) The markets might have started stock exchanges in the later period;
- b) The source, Bloomberg, might not have collected information for these countries even though stock exchanges existed; and
- c) Any other reason.

Daily mean return and volatility (standard deviation) are calculated for each country. However, in the long run daily return works out to 0.04 percent for USA, and for many other developed countries it varies from 0.02 percent to 0.04 percent. Some of the emerging markets, in fact, have negative returns even over a very long period of time. For example Indonesia recorded -0.01 percent returns. One interesting observation is that many emerging markets witnessed almost zero returns and high volatility which implies that these markets provide low or negative rate of returns with high volatility. Fund Managers and other investors have a lesson here. Emerging markets exhibit bouts of return and volatility patterns. Therefore, investors should enter and exit at appropriate time otherwise they would be losers. The experience of India tells a different story. It provides a daily average rate of return of 0.04 percent and a volatility of 1.89 percent for a long period of time (Sensex) which is far better than the rest of the emerging market and many of the major markets.

Both returns and volatility exhibit high variation over a period and across countries. In 1987, USA experienced high daily volatility of 2.12 percent compared to average of 1.07 percent. Again in 2002 and 2000 the volatility in the US was 1.64 percent and 1.40 percent respectively. From the Table 1 it is clear that second part of the 1990s and 2000, 2001 and 2002 experienced consistently high volatility when compared to preceding period as well as to the average. The years 1995, 1993 and 1992 had low volatility of 0.49 percent, 0.54 percent, 0.61 respectively in the USA.

The third largest equity market in the world reside in the UK (in terms of market capitalization). The UK provides equal average returns but high dispersion compared to the US with 0.04 percent average daily returns and 1.23 percent standard deviation. The volatility was at its peak in 1984 with 2.72 percent followed by 2.52 percent (1985) and 1.82 percent (1987). 1996, 1995 and 1994 were relatively calm years with 0.63 percent, 0.74 percent and 0.81 percent volatility respectively. Between the US and the UK, the UK experienced higher volatility, both on high and low sides as well as average.

Other major markets analyzed include France, Germany and Australia. From the Table 1 it is clear that these countries do exhibit low return and higher volatility compared to the US. The average return in France, Germany, and Australia were 0.03 percent, 0.04 percent and 0.02 percent whereas the volatility was 1.40 percent, 1.44 percent and 1.21 percent respectively. Among these countries, Australia had highest volatility of 2.61 percent in 1987 followed by Germany at 2.39 percent and France 2.29 percent in 1987. One significant observation is that all these countries including emerging markets countries experienced high volatility from 1997 to 2002 which indicates that there is a large co-movement in the prices of indices and in the underlying stocks. This also provides evidence to indicate extent of globalization of markets. Yet another observation is in 2003, the volatility slowed down in almost all the countries which is analyzed in this sample. One more interesting finding is that 2000, 2001 and 2002 are the years in which many countries threw up negative returns and in these years by and large the volatilities have been higher than immediate preceding years with positive returns. There is a large literature which corroborates evidence on longer persistence of negative volatility and the negative volatility being higher than the positive volatility.

A close look at the Table 1, further reveals that emerging markets experienced higher volatility accompanied by lower or negative return. Malaysia, Thailand, China, Indonesia, Chile, Brazil, Mexico, South Africa, South Korea and Taiwan all support this finding. China and India are to

some extent exceptional. China has a short history of capital market and in this short history it provided daily average returns of 0.04 percent, the same as of USA. However, its volatility is almost twice as much of USA. India with its long history provides higher return of 0.04 percent with a low volatility compared to China but higher than America. Countries like Indonesia, Brazil and Mexico have had very high volatility of 10.49, 6.97 and 3.96 respectively in certain years.

Emerging markets also recorded very high volatility in several years. Indonesia had the highest volatility of 10.49 percent (1998) followed by 7.38 percent (2000), 7.27 percent (2001), Brazil with 6.97 percent (1992), 3.93 percent (1994), 3.68 percent (1995), Mexico with 3.96 percent (1995), 2.72 percent (1998) and 2.64 percent (1994). Though India did show some amount of high volatility but it is low compared to any of these emerging countries. The highest was in 1992 at 3.45 percent followed by 2.50 percent (1990) and 2.23 percent (1991). India recorded lowest volatility in 2002 at 1.11 percent followed by 1.18 percent (2003) 1.32 percent (1995).

The daily average return and average volatility are useful to the policy makers, regulators, market participant and even investors. Volatility figures are also important for derivative traders. Still many traders continue to use realized volatility as opposed to implied volatility.

Table 2, provides statistics pertaining to asymmetries such as skewness and kurtosis (higher order moments). There is a clear patterns available between developed capital markets and emerging capital markets overtime. Developed markets experienced very high negative skewness and high kurtosis in 1987 which was extremely undesirable because all the returns earned by investors previously were erased. Countries like Hongkong, (China), Australia, USA, The UK, among developed markets have had very high kurtosis, in that order, apart from negative skewness. The late 1980's and the late 1990's exhibited asymmetry in return distributions. Reasons for this behavior include 1987 great fall in the US stock market and its contagion effect on some of the markets. The East Asian crisis could be one of the reasons for the negative skewness and high kurtosis. Stock markets were relatively stable and returns followed near normal distribution for the past five years (1999 to 03).

Higher order moments for sensx and Nifty are calculated from 1985 and 1995 respectively. Surprisingly, Indian market indices showed very high stability and normality. Both skewness and kurtosis are relatively low. In the years, 1987, 1997, and 1998, the third and fourth order moments are comparatively low. Like other markets, India also followed quieter moments from 1999 to 2003. it may be possible to conclude that Indian market exhibited less asymmetry in the entire period.

Inter and Intra-day volatility

So far we have discussed inter-day volatility by computing close to close index level on daily basis. For many fund managers, investors, regulators and policy makers, in the recent times, intra-day volatility has assumed considerable significance because of its influence on the decision of the market participants and its impact on other instruments such as derivatives. Several metrics are employed to estimate intra-day volatility :

- (a) open-close index level
- (b) high low index level and
- (c) open to open index levels

For all the sample countries and for India, these metrics are computed. Open to close volatility provide information on change of the prices during the day. There is an elaborate literature to show that volatility is a function of length of time that means, longer the trading hours higher is the expected volatility. This is important mainly for India as the trading hours increased over a period of time. In the open-out-cry system, the market was open for about two hours. Later on number of trading hours were extended. With the implementation of computer screen based trading, number of trading hours have been enhanced. Now the market is open for almost 6 ½ hours. Therefore, one has to keep this in mind while interpreting the results.

High-low volatility conveys extreme movements and dispersion during the trade time. A very high high-low volatility is likely to scare investors and lead sometimes to panic conditions in the market place. Therefore, regulators, policy makers and SROs strive to implement policies that smoothen information flow and they also ensure certain measures which ensure bounded extremes with the help of circuit breakers, exposure limit, margin etc. Open to open volatility is very important for several of the participants. High open to open volatility reveals informational asymmetry and also overflow of information. Any positive or negative information that comes after the close of the market and before the start of the next day's trading, is expected to get reflected in the opening prices of shares and on the index. Significant economic and socio-political developments induce price movements and the extent of price movement depend on severity of information.

Intra-day volatility and developed capital markets

In the US, open to open and close to close volatility appears to be neck to neck. This indicates smooth flow of information during the day as well as over-night. Extreme volatility, high-low is the highest among the four types of volatility measured as was the case with inter-day volatility. It appears that the US also scores over other developed markets in terms of intra-day volatility. In the UK, intra-day volatility, open to open, is slightly higher than inter-day volatility and lower than open to close volatilit ies. High-low volatility, in the UK also, is the highest among all volatility. The volatility is on the rise for the past five years. France scored higher volatility compared to the UK and USA. Open to close volatility, in case of France, is lower than open to open and close to close. The volatility in Germany is higher than France, The UK and USA. High-low volatility appears to be very high in Germany. In the year 2002, 2001 and 2003, it almost touched 3 percentage points and peaked at 3.79 percent in 2002 and it appears to be highest among all the developed markets in that year. Intra-day dispersion is also high. Australia appears to have comparatively quieter markets. Intra-day and inter-day movements in stock prices are considerably stable in Australia. Inter-day volatility has been consistently lower than 1 percent and it is half of it in 2002 and 2003. Even the high and low price movement variation is also low.

Emerging capital markets

Emerging markets exhibited higher intra-day volatility compared to developed markets. It is a sign of an emerging market owing to economic and socio-political variations, the volatility in the emerging markets is generally on the high side. Countries like Indonesia, Brazil and South Korea, did show higher intra-day volatility. Among all the emerging countries studied, Brazil

experienced very high intra-day volatility and also extreme value volatility followed by Indonesia, South Korea and Mexico.

Intra-day volatility for India has been computed for 13 years. Compared to most of the emerging markets sampled here, intra-day volatility in India is low. Extreme value volatility touched its peak in 2000 at 3.17 percent and it continuously slid in the following years and marginally increased to 1.69 percent in 2003. Between BSE Sensex and S&P, CNX, Nifty, Nifty appears to be more volatile both in terms of open to close and high low dispersions. In India open to open, volatility is always higher than close to close volatility and many a times higher than open to close. This observation holds true to both the major exchanges. Intra-day volatility in 2003 has been very slightly higher than the immediate preceding years though nothing disturbing is evidenced. Only Nifty showed a little more intra-day volatility compared to the previous year and to the Sensex.

Indian Market

There have been reports, mostly in the popular press, citing that the intra-day volatility in particular and volatility in general went up in 2003 and more so in the first three months of 2004. An attempt has been made to calculate inter and intra-day volatility for both Sensex and Nifty with reference to these periods also. A close examination of the Tables 4, 5 and 6 with regard to open to close volatility and high low volatility reveals that the perceptions are not altogether correct. In fact, although the parameters registered their peak in 2000, they fell down further in 2001 and 2002. However, the volatility as per these two parameters in 2003 is only slightly higher compared to 2002, but when compared to 2001 and 2000 this is much lower and about 50 percent of what it was in 2000. In the first 3 months of 2004 volatility calculation reveals that high low volatility slightly went up in January 2004 to 2.10 percent but it is much lower than what was recorded in 2000 and 2001. Open close volatility however, continuous to be low and although the parameters further receded in February and March 2004. The results are more or less the same for both the Indian indices.

Tables 8 and 9, Charts 3 and 4 provide information on inter and intra-day volatility for both Sensex and Nifty in terms of Indian rupees (not adjusted for \$ terms). The tables and charts evidently exhibit a close relationship between inter and intraday relationship. Close to close and open to open volatility moved in tandem with little divergence in a few periods. This little divergence was evident from 1997 to 2002. The volatility levels are almost identical. As per finance theory, in an efficient market both are supposed to be almost the same because the time length is identical and if there are no informational asymmetry then these two parameters converge and have identical volatility. Only in case of Nifty, the divergence was little higher and it was highest in 1997. From 1998 the indicators traveled nearly together. Intra-day volatility parameters : open-close and high-low also experienced close togetherness excepting for 1991. The integration between these two parameters is higher in case of Sensex, compared to Nifty. The divergence, Nifty, prevailed for the entire period from 1995 to 2003 and they never crossed. This is something very intriguing and deserves micro investigation for the purpose of effective dissemination of information.

High and low volatility (Volatility Transmission)

With a view to finding out the extent of integration and segmentation of market it was decided to identify the top three and bottom three volatility years for each country in the sample. If one country (mainly the dominant market) experiences extreme volatility in any given date/given

period and if markets are integrated then, the volatility is expected to get transmitted from one market to another. Many institutional investors are common throughout the world, due to globalization. Therefore, sudden change in volatility will affect the sentiments of investors and it will have impact on other markets also.

In 1987, USA exhibited highest volatility which is also seen in the UK, France, Germany, Australia, Hong Kong, Singapore, Malaysia and Thailand, while rest of the countries did not feel it. If we look at the non-affected countries, they were basically closed or semi-closed markets in 1987 and in some countries such as China, Indonesia, did not have markets. USA had the lowest volatility in 1995 which is felt in other countries, mainly major markets, such as the UK, Germany, Australia, Thailand and Korea. In other words, it may be reasonable to conclude that volatility transmits across countries if there is a financial market integration. Therefore, policy makers and regulators have to be extremely cautious while initiating measures that affects stock prices. It also demands high level of information sharing and also co-ordination so that markets across the globe will have less of volatility or sudden bouts of volatility which is likely to affect investor sentiments.

Extreme volatility analysis (India)

Charts for BSE Sensex and NSE Nifty and tables for both the indices are drawn separately with extreme positive and negative price movements. In this analysis highest index movement on any day in a year has been identified. Following 10 day price movement have been analyzed to find out the extent of persistence in volatility. From the charts and the tables¹, it is clear that the negative volatility is highest in 1991, 1992 and 1993. Negative price movements crossed 15 percent in 1993 and it was about 15 percent and 10 percent in 1991 and 1992 respectively. Whenever, the volatility was higher, it was negative volatility. When the volatility is stable, the positive volatility is higher than the negative volatility. For example in 1994, 1995 and 1996, the price variation is higher on positive side compared to negative side. Even 2002 and 2003, also witnessed higher positive variation and the years are relatively more stable. From the data it is clear that negative variation persist for longer period compared to positive volatility. The depth also is higher for negative volatility.

Return squared volatility

As far as India is concerned, one more different metric has been computed to measure volatility. In the popular press, many a times, it is found that they have used high-low index levels of the day to compute dispersion and call it volatility. In this procedure there are several pitfalls. Therefore, here we used a new measurement to compute volatility. As a first step, relative logarithmic return on close index value are used for computing relative return. The relative returns are squared and converted into percentage. Here one significant assumption is that daily average return is expected to be zero which is by and large true if we examine closely all the data provided in Table 1 for various countries. As a next step, average volatility for the entire year is calculated and top 5 percent of the returns (in absolute terms) are computed to see the difference between the average and extremes.

¹ Owing to space restrictions and with a view to providing smooth reading through the article some of the tables and charts are not included in the paper. However, the interested readers are most welcome to contact the authors and/or Research Department, SEBI for obtaining tables and charts.

From the Table No. 10 it is clear that volatility measured by this way also confirms that the broad finding of standard measurement such as standard deviation, employed previously. Yearly average as well as top 5 per cent attained high in 1992, 1997 to 2000. Extreme volatility has been high although, average volatility came down between 1997–1999. The year 2002 is a relatively stable year. On both the exchanges, this new measurement also throws up that volatility in 2003 is slightly higher than the preceding years. Maximum volatility was recorded at 12.34 percent in 1992 and second highest in 1999 at 8.66 percent. The lowest volatility is in 2003.

Return squared analysis

The observation that stock-price breaks (negative) are more severe than upward variation is also consistent with investors being loss averse, tending to focus on negative information when under stress overweighting the probability of negative events, and becoming more loss averse as downward movements in the value of their portfolios remind them of their incomplete personal control.

Neoclassical economic models assume that negative feedback always dominates, however, and that prices tend toward stability.

The data has been looked at from different angle without using the traditional method of using standard deviation. For this process daily returns are calculated which are squared and converted into percentage. Thereafter square root is taken. The average is calculated which is necessary to give a summary statistic. For each year, top 5 percent (ignoring sign) of the observations are separated to calculate average of 5 percent. This will help to identify the pattern of extreme volatility and its behavior.

From Table 10, we can observe that the broad contours of this table across that of overall volatility figures in other tables. Although, yearly average on top 5 percent were high in 1992 followed by 1991, thereafter, the volatility continued to fall till 1996. 1997 to 2000 the volatility again went up. Thereafter, it fell down and fell down sharply by almost 50 percent in 2002 compared to 2000. The stock market volatility in India has a lot to do with domestic market related developments. High volatility periods of 1990's and also part of 2000 can be clubbed into 3 periods. Most of the high volatility can be attributed to some of the irregularities that occurred on the Indian stock exchanges in 1991-92 and 1997-98 and again in 2000-01. But for these irregularities, Indian stock markets are by and large stable and volatility has been under control.

Conclusion & Recommendation :

- As expected daily average return and daily volatility across markets vary over time and space. Their divergencies are highly demonstrable. Some countries (US) provide as high as 0.04 percentage return while some of the emerging markets such as Indonesia recorded negative returns of -0.01 percentage. India is a bright spot. In the sample period Indian investors could obtain as high as 0.04 percentage return with a moderate volatility of 1.89 percent. Volatility or rather the lack of it. All the banks with big equities business have moaned that the low volatility of stock prices over the past few months has been making life difficult. While stock prices have risen sharply over the last year, on a daily basis they have been usually stable. Firms such as Bear Stearns make a good deal of their money from exploiting the bumps and wrinkles in markets, which drive profits in derivatives, arbitrage and all kinds of market making.

- Views differ on what has been behind the decline and what it means for the future. Traditionally, market watchers see high volatility as a sign of investor nervousness which, in the counter-intuitive world of markets, is, of course, bullish. Conversely, low volatility is viewed as a **sign** of investor confidence or even complacency and a warning of a market downturn. (David Wighton, Financial Times 20-21 March 2004)
- Some of the countries such as the UK, France, Germany and Australia provide low return and higher volatility (compared to the U.S.).
- Many of the developed markets and all emerging markets experienced high volatility during 1997 to 2002 indicating convergence of markets.
- Volatility was low in 2003 in almost all the countries.
- The years 2000, 2001 and 2002 were bad for investors with very low or negative returns and high volatility.
- The returns on portfolio of stocks (index) are more or less normally distributed. Because normal distributions are fully described by their mean and standard deviation, the risk of such portfolios can indeed be measured with one number. Confronted with non-normal distributions, however, it is no longer appropriate to use the standard deviation as the sole measure of risk. In that case investors should also look at the degree of symmetry of the distribution, as measured by its so-called 'skewness', and the probability of extreme positive or negative outcomes, as measured by the distributions, 'kurtosis'. A symmetrical distribution will have a skewness equal to zero, while a distribution that implies a relatively high possibility of a large loss (gain) is said to exhibit negative (positive) skewness. A normal distribution has a kurtosis of 3, while a kurtosis higher than 3 indicates gain. Since most investors are in it for the longer run, they strongly rely on compounding effects. This means that negative skewness and high kurtosis are extremely undesirable features as one big loss may destroy years of careful compounding.
- Higher order movements, skewness and kurtosis, provide additional information about the nature of return distribution. Negative skewness and high kurtosis are extremely harmful to investors (long only).
- 1987, the stock markets of the US, Hong Kong (China), Australia, France, The UK and Germany had negative skewness and large kurtosis. The late 1980s and a part of the late 1997's across markets, showed both negative third and large fourth order movement.
- Return distributions have been relatively stable for the past five years (1999-2003) that perhaps, provided less variant in return and positive returns. Markets considerably expanded during these years.
- Surprisingly and unexpectedly, Indian stock market stood out as a normally distributed market. Indeed, it is a very positive indicator as far as India and Indian regulator are concerned.
- The discovery of nonlinearity in security prices and the fact that outcomes can be predicted only within wide limits also have normative implications for financial decision making.
- As far as the US market is concerned both open to open and close to close volatility appears to be almost identical. Close approximation signals smooth flow of information during and after the market hours.
- Countries like France, experienced lower open to close volatility than open to open and close to close. The volatility is higher in Germany than in France, the UK and USA.
- Emerging market countries like Indonesia, Brazil, South Korea exhibited high intra-day volatility. Among these countries, Brazil had higher intra-day volatility.

- Compared to emerging markets and some of the developed markets – India experienced low intra-day volatility. Extreme value volatility, in India, touched its peak in 2000 at 3.17 per cent and continuously slid thereafter.
- Volatility transmission appears to be strong For eg. in 1987, USA recorded highest volatility which was also seen in other countries like the UK, France, Germany, Australia, Hong Kong, Singapore and Thailand.
- And in 1995, the US markets recorded low volatility which is again observed in the UK, Germany, Australia, Thailand and Korean markets.

References:

Box, G and D. Pierce, “Distribution of Residual Autocorrelations in Autoregressive-Integrated Moving Average Time Series Models,” Journal of the American Statistical Association, Vol 65, 1970, pp 1509-1526

Bekaert, Geert and Campbell, R. Harvey (1995), Emerging Equity Market Volatility, National Bureau of Economic Research (NBER), Working Paper 5307, pages 1 – 77

Garman, M and M. Klass. “On the Estimation of Security Price Volatilities from Historical Data,” Journal of Business, Vol 53, 1980, pp 67-78

Ljung, G and G. Box, “On a Measure of Lack of Fit in Time Series Models,” Biometrika, Vol 66, 1978, pp 67-72

Lo and A.C. MacKinlay, “Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test,” Review of Financial Studies, Vol 1, 1988, pp 41-66

Miller, Merton H. (1991), Financial Innovations and Market Volatility, Blackwell, pages 1 - 288

Parkinson, M “The Extreme Value Method for Estimating the Variance of the Rate of Return”, Journal of Business, Vol 53, 1980, pp 61-65

Schwert, G. William (1989a), Why does stock market volatility change over time, Journal of Finance, 44, pages 1115 – 1154

Schwert, G. William (1989b), Business cycles, financial crises and stock volatility, Carnegie-Rochester Conference Series on Public Policy, 31, pages 83 - 126

Table 3: Top Three and bottom three volatility figures

USA	UK	France	Germany	Australia	Hongkong
H ₁ 2.12 (87) L ₁ 0.49 (95)	H ₁ 2.72 (84) L ₁ 0.63 (96)	H ₁ 2.29 (87) L ₁ 0.75 (96)	H ₁ 2.39 (02) L ₁ 0.77 (96)	H ₁ 2.61 (87) L ₁ 0.88 (92)	H ₁ 3.21 (87) L ₁ 1.07 (96, 03)
H ₂ 1.64 (02) L ₂ 0.54 (93)	H ₂ 2.52 (85) L ₂ 0.74 (95)	H ₂ 2.11 (02) L ₂ 1.07 (89, 94)	H ₂ 1.80(87,98) L ₂ 1.05 (84,95)	H ₂ 1.31 (85) L ₂ 0.89 (95)	H ₂ 2.78 (98) L ₂ 1.11 (86)
H ₃ 1.40 (00) L ₃ 0.61 (92)	H ₃ 1.82 (87) L ₃ 0.81 (94)	H ₃ 1.64 (91) L ₃ 1.09 (88, 93)	H ₃ 1.74 (01) L ₃ 1.08 (93)	H ₃ 1.25 (89) L ₃ 0.90 (96)	H ₃ 2.53 (97) L ₃ 1.13 (91)

Singapore	Malayasia	Thailand	China	Indonesia	Chile
H ₁ 2.89 (98) L ₁ 0.84 (93)	H ₁ 4.82 (98) L ₁ 0.73 (03)	H ₁ 3.57 (98) L ₁ 1.19 (89)	H ₁ 2.97(95) L ₁ 1.14 (03)	H ₁ 10.49 (98) L ₁ 1.32 (03)	H ₁ 1.51 (91) L ₁ 0.72 (97)
H ₂ 2.86 (87) L ₂ 0.85 (96)	H ₂ 2.87 (97) L ₂ 0.81 (92)	H ₂ 3.28 (97) L ₂ 1.27 (93, 95)	H ₂ 2.72 (96) L ₂ 1.33 (98)	H ₂ 7.38 (00) L ₂ 1.62 (93)	H ₂ 1.24 (95) L ₂ 0.76 (93)
H ₃ 1.61 (00) L ₃ 0.91 (92)	H ₃ 2.69 (87) L ₃ 0.82 (02)	H ₃ 2.65 (87) L ₃ 1.29 (03)	H ₃ 2.23 (97) L ₃ 1.37 (00)	H ₃ 7.27 (01) L ₃ 1.64 (95)	H ₃ 1.20 (98) L ₃ 0.82 (03)

Brazil	Mexico	South Africa	Korea	Taiwan	Sensex
H ₁ 6.97 (92) L ₁ 1.46 (96)	H ₁ 3.96 (95) L ₁ 1.67 (03)	H ₁ 2.29 (98) L ₁ 0.54 (95)	H ₁ 4.03 (98) L ₁ 1.03 (90)	H ₁ 3.74 (90) L ₁ 0.82 (85)	H ₁ 3.45 (92) L ₁ 1.11 (02)
H ₂ 3.93 (94) L ₂ 2.06 (03)	H ₂ 2.72 (98) L ₂ 1.27 (93)	H ₂ 1.53 (01) L ₂ 1.11 (96)	H ₂ 3.75 (97) L ₂ 1.11 (95)	H ₂ 2.45 (91) L ₂ 0.88 (86)	H ₂ 2.50 (90) L ₂ 1.18 (03)
H ₃ 3.68 (95) L ₃ 2.33 (00)	H ₃ 2.64 (94) L ₃ 1.43 (96)	H ₃ 1.52 (02) L ₃ 1.19 (03)	H ₃ 3.20 (00) L ₃ 1.15 (94)	H ₃ 2.22 (00) L ₃ 0.97 (84)	H ₃ 2.23 (91) L ₃ 1.32 (95)

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Table 1 : Stock Index Daily Return Average and Volatility (Percentage)

Year	USA		UK		France		Germany		Australia		Hongkong	
	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV
1980	0.10	1.03	NA	NA	NA	NA	-0.06	1.02	NA	NA	NA	NA
1981	-0.04	0.85	NA	NA	NA	NA	-0.05	1.32	NA	NA	-0.10	2.11
1982	0.05	1.15	NA	NA	NA	NA	0.03	1.12	NA	NA	-0.29	2.46
1983	0.06	0.84	NA	NA	NA	NA	0.08	1.18	NA	NA	-0.03	2.29
1984	0.01	0.80	-0.03	2.72	NA	NA	-0.03	1.05	-0.06	1.02	0.13	1.95
1985	0.09	0.64	0.62	2.52	NA	NA	0.30	1.28	0.05	1.31	0.15	1.41
1986	0.05	0.93	0.08	1.18	NA	NA	0.11	1.46	0.14	1.23	0.16	1.11
1987	0.01	2.12	0.10	1.82	-0.21	2.29	-0.06	1.80	-0.01	2.61	-0.04	3.21
1988	0.05	1.08	0.00	0.88	0.13	1.09	0.07	1.16	0.11	1.20	0.06	1.07
1989	0.10	0.83	0.08	1.14	0.12	1.07	0.14	1.48	0.01	1.25	0.02	2.32
1990	-0.03	1.00	0.02	1.14	-0.06	1.43	-0.05	1.68	-0.11	1.03	0.03	1.20
1991	0.09	0.90	0.05	1.17	0.06	1.64	0.04	1.58	0.10	0.98	0.14	1.13
1992	0.02	0.61	-0.03	1.24	0.00	1.22	-0.03	1.10	-0.06	0.88	0.10	1.43
1993	0.03	0.54	0.06	0.94	0.05	1.09	0.12	1.08	0.13	1.03	0.31	1.43
1994	-0.01	0.62	-0.02	0.81	-0.03	1.07	0.02	1.18	0.00	0.99	-0.15	1.89
1995	0.12	0.49	0.07	0.74	0.03	1.16	0.06	1.05	0.04	0.89	0.08	1.27
1996	0.07	0.74	0.08	0.63	0.06	0.75	0.07	0.77	0.06	0.90	0.12	1.07
1997	0.11	1.14	0.07	0.93	0.04	1.30	0.10	1.42	-0.06	1.16	-0.09	2.53
1998	0.09	1.28	0.06	1.28	0.14	1.54	0.09	1.80	0.02	1.26	-0.03	2.78
1999	0.07	1.13	0.05	1.08	0.10	1.20	0.07	1.35	0.07	0.96	0.21	1.68
2000	-0.04	1.40	-0.07	1.22	-0.03	1.58	-0.06	1.63	-0.06	1.15	-0.05	1.97
2001	-0.06	1.36	-0.08	1.38	-0.12	1.59	-0.11	1.74	-0.01	1.23	-0.12	1.75
2002	-0.11	1.64	-0.07	1.28	-0.09	2.11	-0.16	2.39	-0.01	1.02	-0.08	1.22
2003	0.09	1.07	0.09	1.16	0.13	1.37	0.20	1.71	0.16	0.93	0.12	1.07
1980-1991	0.05	1.08	0.07	1.40	0.03	1.47	0.04	1.37	0.03	1.42	0.02	1.96
1992-2003	0.03	1.07	0.02	1.12	0.02	1.38	0.03	1.50	0.02	1.04	0.04	1.76
1980-2003	0.04	1.07	0.04	1.23	0.03	1.40	0.04	1.44	0.02	1.21	0.03	1.86

Stock Index Daily Return Average and Volatility (Percentage)

Year	Singapore		Malaysia		Thailand		China		Indonesia		Chile	
	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV
1980	NA	NA	0.22	1.32	NA	NA	NA	NA	NA	NA	NA	NA
1981	NA	NA	0.01	1.96	NA	NA	NA	NA	NA	NA	NA	NA
1982	NA	NA	-0.12	1.36	NA	NA	NA	NA	NA	NA	NA	NA
1983	NA	NA	0.13	1.01	NA	NA	NA	NA	NA	NA	NA	NA
1984	NA	NA	-0.13	0.94	NA	NA	NA	NA	NA	NA	NA	NA
1985	-0.08	1.35	-0.11	1.52	NA	NA	NA	NA	NA	NA	NA	NA
1986	0.17	1.24	0.01	1.60	NA	NA	NA	NA	NA	NA	NA	NA
1987	-0.02	2.86	0.03	2.69	-0.02	2.65	NA	NA	NA	NA	NA	NA
1988	0.10	1.22	0.09	1.20	0.12	1.35	NA	NA	NA	NA	NA	NA
1989	0.14	1.17	0.19	1.23	0.32	1.19	NA	NA	NA	NA	NA	NA
1990	-0.05	1.43	-0.04	1.65	-0.14	2.59	NA	NA	NA	NA	NA	NA

1991	0.13	1.15	0.04	1.21	0.06	1.89	NA	NA	0.00	3.41	-0.10	1.51
1992	0.01	0.91	0.07	0.81	0.09	1.63	NA	NA	0.03	2.18	0.02	0.84
1993	0.21	0.84	0.26	1.03	0.26	1.27	NA	NA	0.32	1.62	0.10	0.76
1994	-0.01	1.21	-0.09	1.78	-0.08	1.66	NA	NA	-0.12	1.65	0.15	1.00
1995	0.03	0.96	0.01	1.24	-0.03	1.27	-0.05	2.97	0.02	1.64	0.02	1.24
1996	0.02	0.85	0.09	0.83	-0.18	1.36	0.21	2.72	0.08	1.78	-0.08	0.53
1997	-0.18	1.62	-0.47	2.87	-0.57	3.28	0.11	2.23	-0.49	4.11	-0.03	0.72
1998	-0.02	2.89	0.00	4.82	0.08	3.57	-0.02	1.33	-0.19	10.49	-0.14	1.20
1999	0.23	1.56	0.13	1.73	0.12	2.41	0.07	1.77	0.28	6.61	0.10	0.90
2000	-0.12	1.61	-0.07	1.38	-0.29	2.05	0.17	1.37	-0.38	7.38	-0.05	0.83
2001	-0.09	1.47	0.01	1.28	0.04	1.72	-0.10	1.38	0.00	7.27	-0.01	0.91
2002	-0.05	1.17	-0.03	0.82	0.07	1.38	-0.08	1.54	0.07	3.14	-0.06	0.84
2003	0.09	1.17	0.08	0.73	0.35	1.29	0.04	1.14	0.22	1.32	0.23	0.82
1980-1991	0.06	1.59	0.03	1.54	0.08	1.93	NA	NA	NA	NA	-0.10	1.49
1992-2003	0.01	1.46	0.00	1.97	-0.01	2.06	0.04	1.94	-0.01	5.09	0.02	0.91
1980-2003	0.03	1.51	0.01	1.77	0.01	1.29	0.04	1.94	-0.01	5.07	0.02	0.93

Stock Index Daily Return Aveage and Volatility (Percentage)

Year	Brazil		Mexico		South Africa		Korea		Taiwan	
	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV	MEAN	STDEV
1980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1981	NA	NA	NA	NA	NA	NA	0.05	2.29	NA	NA
1982	NA	NA	NA	NA	NA	NA	-0.04	2.02	NA	NA
1983	NA	NA	NA	NA	NA	NA	-0.04	1.01	0.07	1.02
1984	NA	NA	NA	NA	NA	NA	0.04	1.76	0.04	0.97
1985	NA	NA	NA	NA	NA	NA	0.02	1.57	-0.01	0.82
1986	NA	NA	NA	NA	NA	NA	0.20	1.93	0.12	0.88
1987	NA	NA	NA	NA	NA	NA	0.25	1.69	0.36	2.15
1988	NA	NA	NA	NA	NA	NA	0.24	1.31	0.28	2.06
1989	NA	NA	NA	NA	NA	NA	0.01	1.03	0.25	2.15
1990	NA	NA	NA	NA	NA	NA	-0.11	1.63	-0.27	3.74
1991	NA	NA	NA	NA	NA	NA	-0.07	1.43	0.02	2.45
1992	-0.07	6.97	0.07	1.61	NA	NA	0.02	1.69	-0.10	1.49
1993	0.31	3.37	0.16	1.27	NA	NA	0.07	1.31	0.19	1.66
1994	0.19	3.93	-0.23	2.64	NA	NA	0.08	1.15	0.06	1.52
1995	-0.06	3.68	-0.10	3.96	0.11	0.54	-0.04	1.11	-0.13	1.49
1996	0.17	1.46	0.07	1.43	-0.07	1.11	-0.14	1.20	0.10	1.19
1997	0.12	2.97	0.17	2.05	-0.05	1.43	-0.39	3.75	0.00	1.60
1998	-0.20	3.64	-0.19	2.72	-0.11	2.29	0.22	4.03	-0.08	1.66
1999	0.21	3.34	0.25	2.10	0.19	1.25	0.26	2.70	0.11	1.60
2000	-0.08	2.33	-0.10	2.37	-0.09	1.50	-0.34	3.20	-0.23	2.22
2001	-0.12	2.72	0.07	1.65	-0.08	1.53	0.11	2.57	0.04	2.05
2002	-0.25	2.96	-0.07	1.58	0.10	1.52	0.00	2.15	-0.09	1.81
2003	0.35	2.06	0.11	1.07	0.14	1.19	0.10	1.72	0.12	1.38
1980-1991	NA	NA	NA	NA	NA	NA	0.05	1.63	0.10	0.10
1992-2003	0.05	3.52	0.02	2.18	0.01	1.48	-0.01	2.43	0.00	1.66

1980-2003	0.05	3.52	0.02	2.18	0.01	1.48	0.02	2.08	0.04	1.86
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Stock Index Daily Return Average and Volatility (Percentage)

Year	Sensex		S&P CNX Nifty	
	MEAN	STDEV	MEAN	STDEV
1980	NA	NA	NA	NA
1981	NA	NA	NA	NA
1982	NA	NA	NA	NA
1983	NA	NA	NA	NA
1984	NA	NA	NA	NA
1985	0.33	1.90	NA	NA
1986	-0.04	2.00	NA	NA
1987	-0.07	1.78	NA	NA
1988	0.13	1.71	NA	NA
1989	0.02	1.54	NA	NA
1990	0.11	2.50	NA	NA
1991	0.12	2.23	NA	NA
1992	0.11	3.45	NA	NA
1993	0.08	2.11	NA	NA
1994	0.07	1.44	NA	NA
1995	-0.15	1.32	-0.16	1.31
1996	-0.01	1.59	-0.01	1.59
1997	0.03	1.68	0.04	1.80
1998	-0.11	1.99	-0.11	1.40
1999	0.19	1.82	0.20	1.86
2000	-0.12	2.22	-0.09	2.01
2001	-0.09	1.75	-0.08	1.66
2002	0.02	1.11	0.01	1.11
2003	0.24	1.18	0.23	1.25
1980-1991	0.08	1.97	-	-
1992-2003	0.02	1.85	-	-
1980-2003	0.04	1.89	-	-

Table 2 : Higher Order Moments of Stock Index Daily Returns

Year	USA		UK		France		Germany		Australia		Hongkong	
	SKEW	KURT	SKEW	KURT	SKEW	KURT	SKEW	KURT	SKEW	KURT	SKEW	KURT
1980	-0.21	0.39	NA	NA	NA	NA	-0.01	0.34	NA	NA	NA	NA
1981	-0.06	0.49	NA	NA	NA	NA	0.32	0.66	NA	NA	-0.02	1.97
1982	0.66	1.88	NA	NA	NA	NA	-0.20	1.04	NA	NA	-0.77	3.22
1983	-0.02	0.32	NA	NA	NA	NA	0.05	-0.31	NA	NA	-0.58	2.95
1984	0.81	1.25	-0.12	0.30	NA	NA	0.09	0.34	0.38	1.40	-0.42	3.78
1985	0.44	0.33	-0.27	0.91	NA	NA	-0.06	-0.13	0.09	1.39	-0.17	2.23
1986	-0.98	3.58	-0.34	0.05	NA	NA	-0.04	1.26	-0.84	2.09	-0.02	0.35
1987	-5.02	54.95	-2.86	21.35	-0.96	5.16	-0.90	5.02	-6.45	68.68	-8.43	104.44
1988	-1.04	8.06	-0.34	0.26	-0.03	0.02	-0.12	1.90	-0.39	0.23	0.18	2.48
1989	-1.81	13.82	-0.65	1.14	-0.60	2.05	-1.77	21.72	-2.13	14.33	-5.26	53.79
1990	-0.17	0.63	0.37	2.56	0.06	0.97	0.24	2.18	-0.07	1.14	-0.72	8.28
1991	0.18	2.01	0.02	2.31	-0.81	14.26	-0.51	10.40	-0.36	1.29	-1.66	16.48
1992	0.06	0.27	-0.16	3.45	-0.27	0.82	-0.51	2.11	-0.04	1.11	-0.92	5.89
1993	-0.18	2.49	0.11	0.79	-0.03	-0.22	0.07	0.36	-0.13	1.01	0.22	1.54
1994	-0.29	1.33	0.02	-0.31	0.09	0.25	-0.17	0.14	-0.19	0.31	-0.22	1.06
1995	-0.08	1.13	-0.36	1.30	0.34	1.27	-0.22	0.38	0.09	0.78	0.24	1.95
1996	-0.62	1.81	-0.30	0.00	-0.23	0.06	-0.27	2.17	-0.71	2.47	-1.68	10.45
1997	-0.68	6.66	-0.16	0.82	0.17	1.93	-0.53	2.93	-1.18	10.55	0.18	14.16
1998	-0.62	4.84	0.00	0.63	-0.29	1.06	-0.43	0.64	0.70	2.70	0.62	2.78
1999	0.06	-0.11	0.10	0.04	0.58	3.40	0.43	2.85	-0.20	-0.06	0.16	0.10
2000	0.00	1.44	0.11	0.35	-0.13	-0.08	0.16	-0.14	-0.61	4.05	-0.45	1.79
2001	0.02	1.50	-0.24	1.20	0.06	1.28	-0.12	2.23	-1.04	6.35	-0.40	2.68
2002	0.43	0.70	-0.08	1.11	0.05	0.53	0.07	0.28	0.00	0.90	0.37	0.32
2003	0.28	0.50	-0.03	2.21	-0.17	1.60	-0.12	0.82	-0.20	0.90	0.04	1.27
1980-1991	-3.34	72.15	-1.02	11.92	-0.79	9.57	-0.39	6.19	-5.25	100.16	-4.49	79.74
1992-2003	-0.11	3.80	-0.13	2.16	-0.04	1.80	-0.15	2.13	-0.34	3.90	0.04	8.54
1980-2003	-1.74	38.46	-0.58	8.13	-0.27	4.33	-0.25	3.83	-3.53	77.88	-2.52	51.14

Higher Order Moments of Stock Index Daily Returns

Year	Singapore		Malaysia		Thailand		China		Indonesia		Chile	
	SKEW	KURT	SKEW	KURT	SKEW	KURT	SKEW	KURT	SKEW	KURT	SKEW	KURT
1980	NA	NA	-0.88	3.94	NA	NA	NA	NA	NA	NA	NA	NA
1981	NA	NA	-0.88	3.18	NA	NA	NA	NA	NA	NA	NA	NA
1982	NA	NA	0.12	0.73	NA	NA	NA	NA	NA	NA	NA	NA
1983	NA	NA	-0.32	0.77	NA	NA	NA	NA	NA	NA	NA	NA
1984	NA	NA	0.66	1.58	NA	NA	NA	NA	NA	NA	NA	NA
1985	-2.95	30.23	-1.57	15.19	NA	NA	NA	NA	NA	NA	NA	NA
1986	0.40	1.03	0.44	0.98	NA	NA	NA	NA	NA	NA	NA	NA
1987	-4.52	48.28	-1.76	13.79	-1.24	2.72	NA	NA	NA	NA	NA	NA
1988	0.01	6.34	-0.28	3.81	-0.01	6.54	NA	NA	NA	NA	NA	NA
1989	-2.41	26.13	-3.90	41.69	-0.34	10.84	NA	NA	NA	NA	NA	NA
1990	-0.58	5.20	-0.94	7.10	-1.31	9.66	NA	NA	NA	NA	NA	NA
1991	-0.35	8.38	-0.37	7.66	0.21	3.23	NA	NA	0.00	3.69	-0.24	0.06
1992	0.09	1.11	0.26	1.30	-0.02	8.81	NA	NA	0.16	8.12	0.67	3.37
1993	0.43	1.30	0.25	1.24	0.21	1.34	NA	NA	1.70	9.31	1.26	6.13
1994	-0.14	2.89	-0.05	5.57	-0.72	3.38	NA	NA	-0.25	4.09	-0.33	0.46
1995	-0.60	3.82	0.70	2.35	0.04	2.48	2.47	32.14	0.75	9.95	0.61	3.38
1996	-0.40	1.91	-0.40	2.21	-0.32	2.84	-0.35	2.64	-0.20	3.73	0.42	0.00
1997	0.01	8.89	0.36	6.29	0.25	2.73	-1.01	3.76	-1.11	8.19	-0.53	3.75
1998	0.74	4.61	1.53	13.82	0.68	2.46	-1.08	7.98	0.11	5.17	-0.05	2.50
1999	-0.01	1.15	0.10	1.53	0.98	2.88	0.35	2.90	0.08	4.38	-0.43	1.20
2000	-0.59	3.87	-0.17	1.92	-0.15	0.85	0.60	6.89	-0.12	4.39	0.62	2.29
2001	-0.59	3.10	-0.98	5.70	-0.10	2.18	0.67	10.16	0.00	11.14	-0.58	2.85
2002	0.60	1.80	0.14	1.14	-0.19	0.69	1.06	7.53	1.79	36.03	-0.08	-0.15
2003	-0.05	0.31	0.39	1.22	-0.04	0.16	0.86	2.70	-0.09	0.95	-0.28	1.00
1980-1991	-4.19	77.51	-1.32	16.28	-1.12	10.54	NA	NA	NA	NA	-0.24	0.06
1992-2003	0.31	10.53	1.82	50.61	0.32	6.44	0.88	24.20	0.00	19.74	0.09	3.20
1980-2003	-1.62	40.76	0.81	43.60	-0.01	7.31	0.88	24.20	0.00	19.78	0.04	3.07

Higher Order Moments of Stock Index Daily Returns

Year	Brazil		Mexico		South Africa		Korea		Taiwan	
	SKEW	KURT	SKEW	KURT	SKEW	KURT	SKEW	KURT	SKEW	KURT
1980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1981	NA	NA	NA	NA	NA	NA	0.07	2.28	NA	NA
1982	NA	NA	NA	NA	NA	NA	-0.09	5.90	NA	NA
1983	NA	NA	NA	NA	NA	NA	-1.51	34.68	-0.65	4.68
1984	NA	NA	NA	NA	NA	NA	0.24	9.46	-0.47	1.92
1985	NA	NA	NA	NA	NA	NA	0.13	12.87	0.07	0.24
1986	NA	NA	NA	NA	NA	NA	0.20	1.69	-0.67	0.89
1987	NA	NA	NA	NA	NA	NA	-0.13	2.62	-0.33	-0.31
1988	NA	NA	NA	NA	NA	NA	-0.08	0.71	-0.42	-0.62
1989	NA	NA	NA	NA	NA	NA	0.44	1.76	-0.34	0.15
1990	NA	NA	NA	NA	NA	NA	0.62	1.44	-0.10	-0.76
1991	NA	NA	NA	NA	NA	NA	0.21	1.62	-0.20	1.26
1992	-0.79	12.16	-0.34	1.16	NA	NA	0.17	0.27	-0.59	2.43
1993	-0.20	0.57	0.04	0.15	NA	NA	-0.10	1.48	0.40	0.89
1994	-0.30	0.50	-2.01	17.96	NA	NA	-0.25	1.37	-0.37	3.47
1995	1.07	7.82	0.67	8.21	0.15	-0.18	0.40	1.46	-0.20	2.05
1996	0.08	1.71	0.42	0.90	-0.39	1.94	0.00	0.30	-0.51	5.30
1997	-1.10	5.72	-2.46	28.33	-3.34	35.88	0.37	17.30	-0.81	1.97
1998	0.05	4.16	0.42	6.80	-0.69	2.25	0.37	1.26	0.28	1.38
1999	0.56	8.23	0.06	1.64	0.04	3.33	-0.07	-0.04	-0.11	2.12
2000	-0.10	0.21	0.04	1.31	-0.81	4.30	-0.21	0.53	0.14	0.96
2001	-0.25	2.17	-0.05	2.92	0.02	1.80	-0.57	2.21	0.21	-0.13
2002	0.11	0.41	0.11	1.16	-0.33	0.83	-0.19	0.57	0.26	0.56
2003	-0.33	0.37	-0.38	0.63	0.00	0.37	-0.04	0.63	-0.04	1.07
1980-1991	NA	NA	NA	NA	NA	NA	0.11	5.88	-0.37	1.86
1992-2003	-0.49	19.37	-0.14	15.88	-0.87	7.33	0.14	12.01	-0.06	1.71
1980-2003	-0.49	19.37	-0.14	15.88	-0.87	7.33	0.12	12.97	-0.23	2.05

Higher Order Moments of Stock Index Daily Returns

Year	Sensex		S&P CNX Nifty	
	SKEW	KURT	SKEW	KURT
1980	NA	NA	NA	NA
1981	NA	NA	NA	NA
1982	NA	NA	NA	NA
1983	NA	NA	NA	NA
1984	NA	NA	NA	NA
1985	-0.14	1.49	NA	NA
1986	0.37	1.86	NA	NA
1987	-0.70	3.57	NA	NA
1988	0.22	-0.44	NA	NA
1989	0.30	0.84	NA	NA
1990	-0.41	2.08	NA	NA
1991	-1.09	9.19	NA	NA

1992	0.01	2.26	NA	NA
1993	-1.67	11.32	NA	NA
1994	0.57	1.99	NA	NA
1995	0.00	0.35	-0.15	0.42
1996	0.42	0.81	0.58	0.93
1997	-0.28	4.05	-0.39	4.79
1998	0.12	1.54	-0.12	1.97
1999	0.60	2.24	0.51	2.21
2000	-0.25	0.92	-0.11	1.49
2001	-0.50	1.76	-0.50	2.35
2002	0.18	1.51	0.16	1.57
2003	-0.19	0.05	-0.33	0.40
1980-1991	-0.33	3.86	NA	NA
1992-2003	-0.16	5.60	-0.05	2.72

1980-2003

Table 4 : Inter and Intra Day Volatility (without 0.601 factor for H-L Volty.)

Year	USA				UK				France				Germany			
	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1995	0.49	0.52	0.79	0.49	0.74	0.55	0.87	0.85	1.16	0.95	1.46	1.32	1.05	0.00	0.68	1.08
1996	0.74	0.74	1.15	0.73	0.64	0.55	0.86	0.71	0.75	0.71	1.08	0.82	0.77	0.00	0.55	0.65
1997	1.14	1.03	1.62	1.15	0.93	0.98	1.51	1.07	1.30	1.15	1.75	1.68	1.43	0.00	1.00	1.39
1998	1.28	1.20	1.88	1.28	1.28	1.26	1.96	1.40	1.54	1.38	2.11	1.88	1.80	0.01	2.18	1.84
1999	1.14	1.06	1.66	1.14	1.08	1.11	1.72	1.20	1.20	1.15	1.75	1.33	1.35	0.01	1.97	1.52
2000	1.40	1.33	2.07	1.40	1.23	1.19	1.84	1.34	1.58	1.38	2.12	1.84	1.64	1.51	2.33	1.66
2001	1.36	1.25	1.95	1.36	1.39	1.34	2.08	1.52	1.60	1.56	2.40	1.99	1.74	1.92	2.93	2.04
2002	1.64	1.48	2.33	1.63	1.64	1.63	2.55	1.83	2.11	1.91	2.95	2.33	2.39	2.45	3.79	2.62
2003	1.07	0.99	1.55	1.07	1.16	1.15	1.79	1.29	1.37	1.42	2.19	1.75	1.71	0.01	2.97	2.07
1995-2003	1.19	1.10	1.72	1.19	1.16	1.14	1.77	1.29	1.45	1.33	2.05	1.71	1.61	0.01	2.30	1.74
2000-01	1.38	1.29	2.01	1.38	1.31	1.27	1.97	1.43	1.59	1.47	2.27	1.91	2.27	0.01	2.65	2.68
2002-03	1.39	1.26	1.98	1.38	1.42	1.41	2.20	1.58	1.78	1.68	2.60	2.06	2.08	0.01	3.40	2.37

Year	Australia				Singapore				Malaysia				Thailand			
	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1995	0.89	0.57	0.90	0.79	0.96	0.73	1.16	1.07	1.24	0.83	1.36	1.22	1.27	1.05	1.65	1.26
1996	0.76	0.59	0.96	0.86	0.85	0.65	1.04	0.91	0.83	0.66	1.06	0.80	1.36	1.16	1.83	1.46
1997	1.19	0.93	1.45	1.13	1.62	1.05	1.68	1.46	2.87	1.88	2.97	2.48	3.28	1.91	3.02	3.33
1998	1.34	0.87	1.35	1.26	2.89	1.97	3.16	2.82	4.82	2.81	4.49	4.45	3.58	2.37	3.82	3.55
1999	0.96	0.70	1.09	0.99	1.56	1.21	1.91	1.58	1.73	1.52	2.37	1.84	2.40	1.82	2.88	2.50
2000	1.13	0.76	1.20	1.05	1.61	1.22	1.91	1.52	1.38	1.23	1.90	1.38	2.05	1.56	2.48	1.96
2001	1.23	0.69	1.09	1.24	1.47	1.08	1.68	1.58	1.28	1.11	1.73	1.29	1.54	1.42	2.23	1.58
2002	1.02	0.58	0.93	0.95	1.17	0.94	1.47	1.34	0.82	0.67	1.07	0.78	1.38	1.05	1.66	1.43
2003	0.93	0.52	0.83	0.88	1.17	0.93	1.44	1.26	0.73	0.65	1.02	0.74	1.29	1.12	1.76	1.27
1995-2003	1.08	0.70	1.11	1.03	1.58	1.14	1.81	1.59	2.15	1.43	2.27	2.01	2.21	1.56	2.47	2.23
2000-01	1.18	0.72	1.14	1.15	1.54	1.15	1.80	1.55	1.33	1.17	1.82	1.34	1.90	1.49	2.36	1.87
2002-03	0.98	0.55	0.88	0.92	1.17	0.93	1.46	1.30	0.78	0.66	1.04	0.76	1.34	1.08	1.71	1.35

Year	China				Indonesia				Chile				Brazil			
	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1995	2.98	0.00	0.00	2.98	0.89	0.43	0.68	0.88	1.24	0.45	0.74	1.27	3.68	2.81	4.48	3.69
1996	2.72	0.18	0.31	2.70	1.04	0.82	1.32	1.01	0.53	0.39	0.63	0.54	1.46	1.35	2.11	1.47
1997	2.70	0.72	2.91	3.13	2.66	1.66	2.68	2.46	0.72	0.53	0.85	0.75	2.97	2.57	4.04	2.88
1998	1.33	1.19	1.86	1.60	6.96	2.60	4.15	6.78	1.20	0.80	1.33	1.20	3.64	3.15	4.99	3.63
1999	1.77	1.40	2.23	1.89	3.47	2.01	3.16	3.17	0.90	0.63	1.00	0.87	3.34	2.57	4.07	3.76
2000	1.37	1.16	1.85	1.58	2.03	1.44	2.26	1.84	0.82	0.49	0.80	0.76	2.33	1.92	3.00	2.19
2001	1.39	1.07	1.69	1.54	2.22	1.28	2.00	2.04	0.91	0.42	0.69	0.82	2.72	1.95	3.06	2.60
2002	1.54	1.23	1.94	1.67	1.84	1.29	2.05	1.79	0.84	0.36	0.59	0.79	2.96	1.88	2.94	2.87
2003	1.14	1.03	1.62	1.23	1.30	1.05	1.67	1.29	0.82	0.48	0.78	0.81	2.06	1.42	2.21	1.94
1995-2003	1.94	1.14	1.81	2.12	3.14	1.53	2.42	3.00	0.92	0.52	0.85	0.90	2.88	2.25	3.56	2.88
2000-01	1.39	1.12	1.77	1.56	2.13	1.36	2.13	1.94	0.86	0.46	0.75	0.79	2.53	1.94	3.03	2.40
2002-03	1.35	1.13	1.78	1.46	1.60	1.18	1.87	1.56	0.84	0.43	0.69	0.81	2.56	1.66	2.60	2.46

Year	Mexico				South Africa				Korea				Taiwan			
	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1995	3.96	1.93	3.07	4.11	0.54	0.00	0.00	0.54	1.07	0.79	1.23	1.10	1.49	0.00	0.25	1.43
1996	1.43	1.07	1.69	1.39	1.11	0.00	0.00	1.11	1.14	0.96	1.51	1.20	1.19	0.80	1.28	1.28
1997	2.05	1.58	2.49	1.90	1.43	0.00	0.00	1.43	3.73	1.80	2.81	3.34	1.60	1.13	1.81	1.78
1998	2.72	1.96	3.11	2.54	2.29	0.00	0.00	2.29	3.66	2.31	3.60	3.43	1.66	1.08	1.71	1.73
1999	2.10	1.54	2.46	2.08	1.25	0.00	0.00	1.25	2.60	2.18	3.37	2.64	1.60	1.32	2.07	1.80
2000	2.37	1.85	2.95	2.33	1.50	0.00	0.00	1.50	3.10	2.28	3.50	3.12	2.22	1.72	2.71	2.50
2001	1.65	1.23	1.96	1.60	1.53	0.00	0.00	1.53	2.38	1.52	2.36	2.46	2.05	1.58	2.49	2.34
2002	1.58	1.11	1.79	1.48	1.53	0.73	1.15	1.62	2.14	1.57	2.45	2.22	1.81	1.40	2.19	2.07
2003	1.07	0.71	1.15	1.00	1.19	1.00	1.57	1.63	1.72	1.29	1.99	1.85	1.38	1.05	1.63	1.47
1995-2003	2.25	1.50	2.39	2.22	1.48	0.42	0.67	1.54	2.59	1.71	2.65	2.52	1.69	1.21	1.90	1.86
2000-01	2.04	1.57	2.51	2.00	1.51	0.00	0.00	1.51	2.77	1.93	2.98	2.81	2.14	1.66	2.61	2.43
2002-03	1.35	0.93	1.51	1.27	1.37	0.87	1.38	1.62	1.94	1.44	2.23	2.04	1.61	1.23	1.93	1.80

Year	Sensex				S & P CNX Nifty			
	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1991	1.89	0.88	1.71	2.1	NA	NA	NA	NA
1992	3.33	1.47	2.80	3.3	NA	NA	NA	NA
1993	1.83	1.14	1.85	2.1	NA	NA	NA	NA
1994	1.43	0.68	1.35	1.7	NA	NA	NA	NA
1995	1.26	0.64	1.21	1.5	1.33	0.86	1.63	1.48
1996	1.52	1.06	1.94	1.6	1.52	1.08	1.92	1.56
1997	1.62	1.24	2.11	1.7	1.74	1.22	2.26	1.81
1998	1.9	1.36	2.39	2	1.77	1.47	2.65	1.77
1999	2.04	1.4	2.38	2.1	1.89	1.49	2.54	2.2
2000	2.22	2.02	3.17	3.01	2.01	2.21	3.36	2.04
2001	1.75	1.63	2.50	2.01	1.66	1.70	2.61	1.67
2002	1.11	1.03	1.60	1.18	1.07	1.10	1.70	1.07
2003	1.18	1.08	1.69	1.26	1.25	1.30	2.00	1.26
1991-2003	1.89	1.22	2.13	2.80	1.68	1.57	2.42	1.72
1995-2003	1.69	1.41	2.19	1.91	1.68	1.57	2.42	1.72
2000-01	2.00	1.29	2.86	2.56	1.84	1.97	3.01	1.86
2002-03	1.15	1.59	1.64	1.23	1.17	1.21	1.85	1.17

Table 5 : Inter and Intra Day Volatility (with 0.601 factor for H-L Volty.)

Year	USA				UK				France				Germany			
	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1995	0.49	0.52	0.48	0.49	0.74	0.55	0.52	0.85	1.16	0.95	0.88	1.32	1.05	0.00	0.41	1.08
1996	0.74	0.74	0.69	0.73	0.64	0.55	0.52	0.71	0.75	0.71	0.65	0.82	0.77	0.00	0.33	0.65
1997	1.14	1.03	0.97	1.15	0.93	0.98	0.91	1.07	1.30	1.15	1.05	1.68	1.43	0.00	0.60	1.39
1998	1.28	1.20	1.13	1.28	1.28	1.26	1.18	1.40	1.54	1.38	1.27	1.88	1.80	0.01	1.31	1.84
1999	1.14	1.06	1.00	1.14	1.08	1.11	1.03	1.20	1.20	1.15	1.05	1.33	1.35	0.01	1.19	1.52
2000	1.40	1.33	1.24	1.40	1.23	1.19	1.11	1.34	1.58	1.38	1.28	1.84	1.64	1.51	1.40	1.66
2001	1.36	1.25	1.17	1.36	1.39	1.34	1.25	1.52	1.60	1.56	1.44	1.99	1.74	1.92	1.76	2.04
2002	1.64	1.48	1.40	1.63	1.64	1.63	1.53	1.83	2.11	1.91	1.77	2.33	2.39	2.45	2.28	2.62
2003	1.07	0.99	0.93	1.07	1.16	1.15	1.08	1.29	1.37	1.42	1.32	1.75	1.71	0.01	1.78	2.07
1995-2003	1.19	1.10	1.04	1.19	1.16	1.14	1.06	1.29	1.45	1.33	1.23	1.71	1.61	0.01	1.38	1.74
2000-01	1.38	1.29	1.21	1.38	1.31	1.27	1.18	1.43	1.59	1.47	1.36	1.91	2.27	0.01	1.59	2.68
2002-03	1.39	1.26	1.19	1.38	1.42	1.41	1.32	1.58	1.78	1.68	1.56	2.06	2.08	0.01	2.04	2.37

Year	Australia				Singapore				Malaysia				Thailand			
	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1995	0.89	0.57	0.54	0.79	0.96	0.73	0.70	1.07	1.24	0.83	0.82	1.22	1.27	1.05	0.99	1.26
1996	0.76	0.59	0.57	0.86	0.85	0.65	0.62	0.91	0.83	0.66	0.63	0.80	1.36	1.16	1.10	1.46
1997	1.13	0.93	0.87	1.13	1.62	1.05	1.01	1.46	2.87	1.88	1.78	2.48	3.28	1.91	1.81	3.33
1998	1.34	0.87	0.81	1.26	2.89	1.97	1.90	2.82	4.82	2.81	2.70	4.45	3.58	2.37	2.30	3.55
1999	0.96	0.70	0.66	0.99	1.56	1.21	1.15	1.58	1.73	1.52	1.42	1.84	2.40	1.82	1.73	2.50
2000	1.13	0.76	0.72	1.05	1.61	1.22	1.15	1.52	1.38	1.23	1.14	1.38	2.05	1.56	1.49	1.96
2001	1.23	0.69	0.66	1.24	1.47	1.08	1.01	1.58	1.28	1.11	1.04	1.29	1.54	1.42	1.34	1.58
2002	1.02	0.58	0.56	0.95	1.17	0.94	0.88	1.34	0.82	0.67	0.64	0.78	1.38	1.05	1.00	1.43
2003	0.93	0.52	0.50	0.88	1.17	0.93	0.87	1.26	0.73	0.65	0.61	0.74	1.29	1.12	1.06	1.27
1995-2003	1.08	0.70	0.67	1.03	1.58	1.14	1.09	1.59	2.15	1.43	1.36	2.01	2.21	1.56	1.49	2.23
2000-01	1.18	0.72	0.69	1.15	1.54	1.15	1.08	1.55	1.33	1.17	1.09	1.34	1.90	1.49	1.42	1.87
2002-03	0.98	0.55	0.53	0.92	1.17	0.93	0.88	1.30	0.78	0.66	0.63	0.76	1.34	1.09	1.03	1.35

Year	China				Indonesia				Chile				Brazil			
	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1995	2.98	0.00	0.00	2.98	0.89	0.43	0.41	0.88	1.24	0.45	0.44	1.27	3.68	2.81	2.69	3.69
1996	2.72	0.18	0.18	2.70	1.04	0.82	0.79	1.01	0.53	0.39	0.38	0.54	1.46	1.35	1.27	1.47
1997	2.70	0.72	1.75	3.13	2.66	1.66	1.61	2.46	0.72	0.53	0.51	0.75	2.97	2.57	2.43	2.88
1998	1.33	1.19	1.12	1.60	6.96	2.60	2.49	6.78	1.20	0.80	0.80	1.20	3.64	3.15	3.00	3.65
1999	1.77	1.40	1.34	1.89	3.47	2.01	1.90	3.17	0.90	0.63	0.60	0.87	3.34	2.57	2.45	3.76
2000	1.37	1.16	1.11	1.58	2.03	1.44	1.36	1.84	0.82	0.49	0.48	0.76	2.33	1.92	1.80	2.19
2001	1.39	1.07	1.02	1.54	2.22	1.28	1.20	2.04	0.91	0.42	0.41	0.82	2.72	1.95	1.84	2.60
2002	1.54	1.23	1.16	1.67	1.84	1.29	1.23	1.79	0.84	0.36	0.35	0.79	2.96	1.88	1.77	2.87
2003	1.14	1.03	0.97	1.23	1.30	1.05	1.01	1.29	0.82	0.48	0.47	0.81	2.06	1.42	1.33	1.94
1995-2003	1.94	1.14	1.09	2.12	2.20	1.53	1.46	2.07	0.92	0.52	0.51	0.90	2.88	2.25	2.14	2.88
2000-01	1.38	1.12	1.06	1.56	2.13	1.36	1.28	1.94	0.86	0.46	0.45	0.79	2.53	1.94	1.82	2.40
2002-03	1.35	1.13	1.07	1.46	1.60	1.18	1.13	1.56	0.84	0.43	0.42	0.81	2.56	1.66	1.56	2.46

Year	Mexico				South Africa				Korea				Taiwan			
	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1995	3.96	1.93	1.85	4.11	0.54	0.00	0.00	0.54	1.07	0.79	0.74	1.10	1.49	0.00	0.15	1.43
1996	1.43	1.07	1.02	1.39	1.11	0.00	0.00	1.11	1.14	0.96	0.91	1.20	1.19	0.80	0.77	1.28
1997	2.05	1.58	1.50	1.90	1.43	0.00	0.00	1.43	3.73	1.80	1.69	3.34	1.60	1.13	1.09	1.78
1998	2.72	1.96	1.87	2.54	2.29	0.00	0.00	2.29	3.66	2.31	2.16	3.43	1.66	1.08	1.03	1.73
1999	2.10	1.54	1.48	2.08	1.25	0.00	0.00	1.25	2.60	2.18	2.03	2.64	1.60	1.32	1.24	1.80
2000	2.37	1.85	1.77	2.33	1.50	0.00	0.00	1.50	3.10	2.28	2.11	3.12	2.22	1.72	1.63	2.50
2001	1.65	1.23	1.18	1.60	1.53	0.00	0.00	1.53	2.38	1.52	1.42	2.46	2.05	1.59	1.50	2.34
2002	1.58	1.11	1.08	1.48	1.53	0.73	0.69	1.62	2.14	1.57	1.47	2.22	1.81	1.40	1.32	2.07
2003	1.07	0.71	0.69	1.00	1.19	1.00	0.94	1.63	1.72	1.29	1.20	1.85	1.38	1.05	0.98	1.47
1995-2003	2.25	1.50	1.44	2.22	1.48	0.42	0.40	1.54	2.59	1.71	1.59	2.52	1.69	1.21	1.14	1.86
2000-01	2.04	1.57	1.51	2.00	1.51	0.00	0.00	1.51	2.77	1.93	1.79	2.81	2.14	1.66	1.57	2.43
2002-03	1.35	0.93	0.91	1.27	1.37	0.87	0.83	1.62	1.94	1.44	1.34	2.04	1.61	1.23	1.16	1.80

Year	Sensex				S & P CNX Nity			
	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1991	1.85	0.88	1	2.1	NA	NA	NA	NA
1992	3.33	1.47	1.7	3.25	NA	NA	NA	NA
1993	1.83	1.14	1.2	2.12	NA	NA	NA	NA
1994	1.43	0.68	0.8	1.68	NA	NA	NA	NA
1995	1.26	0.64	0.7	1.45	1.33	0.86	0.98	1.48
1996	1.52	1.06	1.2	1.57	1.52	1.08	1.15	1.56
1997	1.62	1.24	1.3	1.66	1.74	1.22	1.31	1.81
1998	1.9	1.36	1.4	1.96	1.77	1.47	1.52	1.77
1999	2.04	1.4	1.5	2.12	1.89	1.49	1.58	2.2
2000	2.22	2.02	1.90	3.01	2.01	2.21	2.02	2.04
2001	1.75	1.63	1.50	2.01	1.66	1.70	1.57	1.67
2002	1.11	1.03	0.96	1.18	1.07	1.10	1.01	1.07
2003	1.18	1.08	1.01	1.26	1.25	1.30	1.20	1.26
1991-99	1.91	1.12	1.2	2.01	NA	NA	NA	NA
1996-99	1.77	1.26	1.3	1.82	1.72	1.30	1.39	1.82
1991-2003	1.89	1.22	1.28	2.80	1.68	1.57	1.45	1.72
1995-2003	1.69	1.41	1.32	1.91	1.68	1.57	1.45	1.72
2000-01	2.06	1.84	1.72	2.56	1.84	1.97	1.81	1.86
2002-03	1.15	1.06	0.99	1.23	1.17	1.21	1.11	1.17

**Table 6: Inter and Intra Day Volatility - India
S & P CNX Nifty (in Dollar terms)**

Year	Close- Close Volatility (%)	Open- Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1995	1.33	0.86	0.98	1.48
1996	1.52	1.08	1.15	1.56
1997	1.74	1.22	1.31	1.81
1998	1.77	1.47	1.52	1.77
1999	1.89	1.49	1.58	2.2
2000	2.01	2.21	2.02	2.04
2001	1.66	1.70	1.57	1.67
2002	1.07	1.10	1.02	1.07
2003	1.25	1.30	1.20	1.26
1996-99	1.72	1.30	1.39	1.82
1995-2003	1.68	1.57	1.45	1.72
2000-01	1.84	1.97	0.90	1.86
2002-03	1.17	1.21	0.56	1.17

**Table 7 :Inter and Intra Day Volatility - India
Sensex (in Dollar terms)**

Year	Close- Close Volatility (%)	Open- Close Volatility (%)	High-Low Volatility (%)	Open- Open Volatility (%)
1991	1.89	0.88	1.03	2.1
1992	3.33	1.47	1.68	3.25
1993	1.83	1.14	1.18	2.12
1994	1.43	0.68	0.81	1.68
1995	1.26	0.64	0.74	1.45
1996	1.52	1.06	1.16	1.57
1997	1.62	1.24	1.29	1.66
1998	1.90	1.36	1.42	1.96
1999	2.04	1.4	1.52	2.12
2000	2.22	2.02	1.90	3.01
2001	1.75	1.63	1.50	2.01
2002	1.11	1.03	0.96	1.18
2003	1.18	1.08	1.01	1.26
1991-99	1.91	1.12	1.23	2.01
1996-99	1.77	1.26	1.34	1.82
1991-2003	1.89	1.22	1.28	2.80
2000-01	2.00	1.29	1.72	2.56
2002-03	1.15	1.59	0.99	1.23

Table 8: Inter and Intra Day Volatility - India Sensex (in Rupee terms)

Year	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1991	7.70	0.00	1.01	7.80
1992	3.62	1.74	1.68	3.49
1993	2.17	1.19	1.11	2.27
1994	1.50	0.83	0.81	1.50
1995	1.38	0.75	0.73	1.39
1996	1.54	1.23	1.17	1.47
1997	1.66	1.36	1.27	1.80
1998	2.00	1.56	1.44	1.79
1999	1.82	1.54	1.43	1.76
2000	2.43	2.02	1.90	2.22
2001	1.87	1.63	1.50	1.62
2002	1.06	1.03	0.96	1.00
2003	1.13	1.08	1.01	0.98
1991-2003	2.66	1.22	1.28	2.63
2000-01	2.17	1.84	1.72	1.94
2002-03	1.10	1.06	0.99	1.00

Table 9: Inter and Intra Day Volatility - India**S & P CNX Nifty (in Rupee terms)**

Year	Close-Close Volatility (%)	Open-Close Volatility (%)	High-Low Volatility (%)	Open-Open Volatility (%)
1995	1.33	1.02	0.98	1.48
1996	1.52	1.23	1.15	1.57
1997	1.79	1.43	1.36	2.01
1998	1.89	1.75	1.60	1.88
1999	1.84	1.66	1.53	1.87
2000	2.00	2.21	2.02	2.03
2001	1.63	1.70	1.57	1.64
2002	1.07	1.10	1.01	1.07
2003	1.23	1.30	1.20	1.25
1995-2003	1.64	1.57	1.45	1.69
2000-01	1.82	1.97	1.81	1.84
2002-03	1.15	1.21	1.11	1.17

Table 10 : DailyAverage Square Root of Return Squared (percentage)				
Year	BSE		NSE	
	Yearly Avg.	Top 5% Avg.	Yearly Avg.	Top 5% Avg
1991	2.27	6.78	NA	NA
1992	3.39	9.02	NA	NA
1993	2.19	5.42	NA	NA
1994	1.50	4.71	NA	NA
1995	1.40	3.58	1.36	2.92
1996	1.60	3.91	1.58	4.00
1997	1.71	5.02	1.82	5.45
1998	2.01	5.24	1.96	5.27
1999	1.89	5.33	1.87	5.34
2000	2.22	5.86	2.01	5.58
2001	1.75	4.90	1.66	4.85
2002	1.11	2.91	1.07	2.79
2003	1.20	2.89	1.27	3.04

Chart 1 :
Inter and Intra-day Volatility (S&P CNX Nifty, in Dollars)

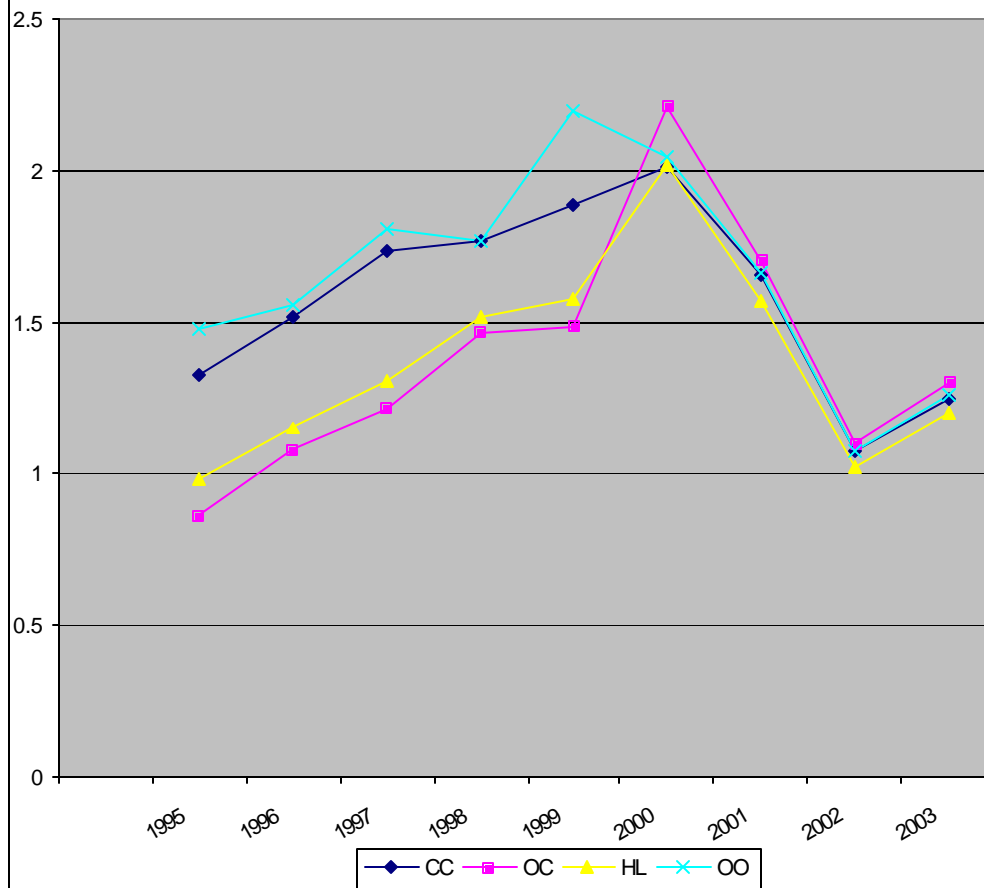


Chart 2 :
Inter- and Intra-day Volatility (Sensex, in Dollars)

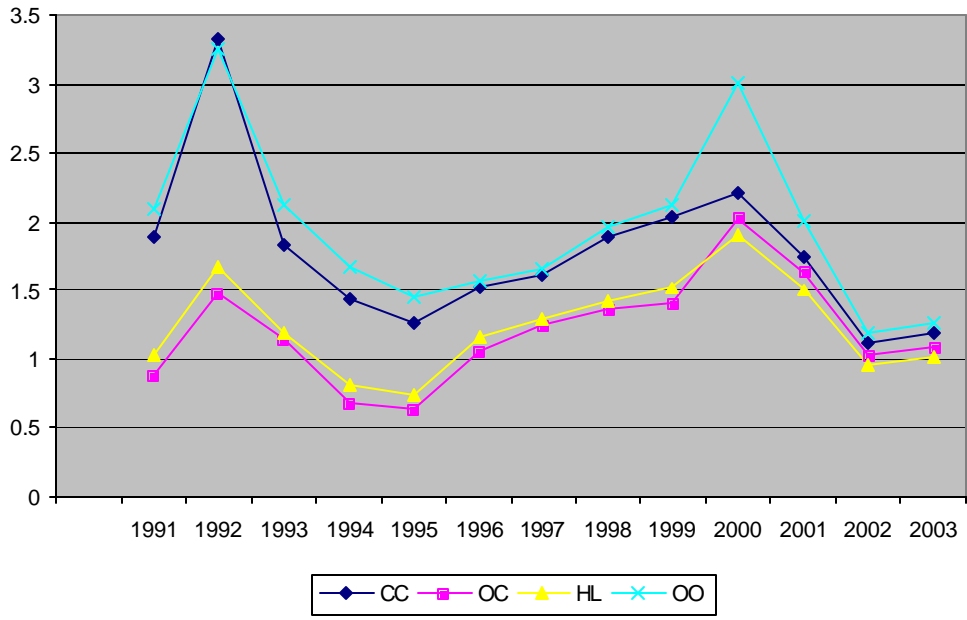


Chart 3 :
Inter and Intra-day Volatility Sensex (in Rupees)

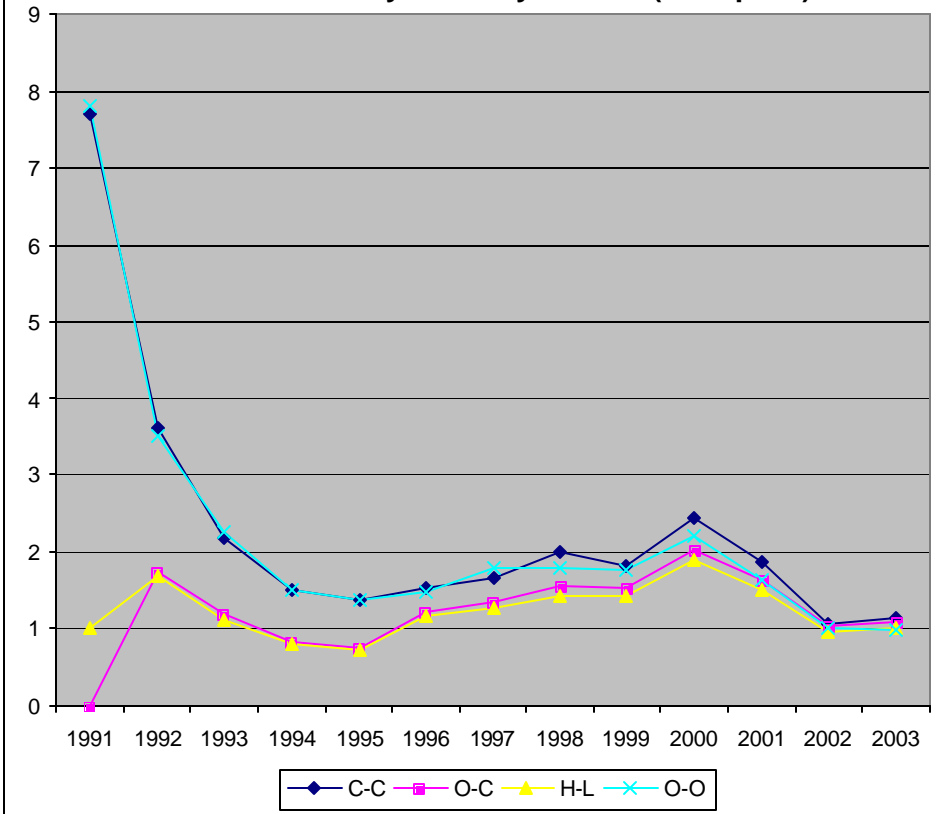


Chart 4 :
Inter and Intra-day Volatility S&P CNX Nifty (in Rupees)

