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EXPLORING STOCK MARKET VOLATILITY CLUSTERING FROM 1991

Dr. Pearly Jacob

Director(IQAC), Dean (Management & Commerce)

Eklavya University, Damoh, India.

Orchid Id:0000-0001-5536-4440

Abstract

Stock market volatility clusters occur when periods of high volatility are followed by periods of low volatility, creating a clustering effect. This phenomenon has been observed in financial markets and is of great interest to investors, traders, and researchers. Understanding the dynamics of stock market volatility clusters is crucial for making informed investment decisions and managing risk. By identifying these clusters, investors can potentially take advantage of periods of high volatility to enter or exit positions strategically.

In this paper the researcher has attempted to define the clusters and then identify the implications of these clusters on the economy.

Key words: Stock market volatility, clusters, macro-economic variables, BSE Sensex

Introduction

Stock market volatility clusters occur when periods of high volatility are followed by periods of low volatility, creating a clustering effect. This phenomenon has been observed in financial markets and is of great interest to investors, traders, and researchers. Understanding the dynamics of stock market volatility clusters is crucial for making informed investment decisions and managing risk. By identifying these clusters, investors can potentially take advantage of periods of high volatility to enter or exit positions strategically.

Researchers have developed various statistical models and techniques to analyze stock market volatility clusters. These models aim to capture the underlying patterns and dynamics that contribute to the clustering effect. By studying historical data and market indicators, analysts can gain insights into the factors driving these clusters and make predictions about future volatility patterns.

The concept of volatility clustering was first introduced by Mandelbrot¹ (1963) and has since evolved. It refers to the empirical observation that periods of high volatility tend to cluster together, and the same is true for periods of low volatility. This clustering can be measured using various statistical models, including the ARCH (Autoregressive Conditional Heteroskedasticity) and GARCH (Generalized Autoregressive Conditional Heteroskedasticity) models. Engle² (1982) introduced the ARCH model, while Bollerslev³ (1986) extended it to the GARCH model, providing more accurate forecasts of volatility.

2. Causes and Determinants of Volatility Clustering:

Time series of financial asset returns often exhibit the *volatility clustering* property: large changes in prices tend to cluster together, resulting in persistence of the amplitudes of price changes. After recalling various methods for quantifying and modeling this phenomenon, we discuss several economic mechanisms which have been proposed to explain the origin of this volatility clustering in terms of behavior of market participants and the news arrival process. A common feature of these models seems to be a switching between low and high activity regimes with heavy-tailed durations of regimes⁴. Numerous factors contribute to the presence of volatility clusters in stock markets:

¹ Mandelbrot, B. (1963) 'The variation of certain speculative prices', *The Journal of Business*, 36(4), p. 394. doi:10.1086/294632.

² Engle, Robert F, 1982. "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation," *Econometrica*, Econometric Society, vol. 50(4), pages 987-1007, July

³ Bollerslev, Tim, 1986. "Generalized autoregressive conditional heteroskedasticity," *Journal of Econometrics*, Elsevier, vol. 31(3), pages 307-327, April.

⁴ Cont, Rama, Volatility Clustering in Financial Markets: Empirical Facts and Agent-Based Models. (May 1, 2005). Available at SSRN: <https://ssrn.com/abstract=1411462> or <http://dx.doi.org/10.2139/ssrn.1411462>.

a. **Market Sentiment:** Sentiment-driven trading behavior can significantly affect stock market volatility. Gervais and Odean⁵ (2001) demonstrated how investor sentiment, as well as herding behavior, can lead to clustering of extreme returns.

b. **Information and News:** The release of information, whether it be earnings reports, macroeconomic data, or geopolitical events, can trigger abrupt changes in volatility. McQueen, Pinegar, and Thorley⁶ (1996) showed that information events create clusters of high volatility.

c. **Liquidity Shocks:** Sudden shifts in market liquidity can lead to unexpected changes in volatility. It was found that changes in liquidity are closely linked to volatility clustering.

d. **Market Microstructure:** The market microstructure, including trading mechanisms and regulations, can influence volatility clustering.

Cluster Identification:

Clusters are categorized on the basis of the similar trends and patterns of volatility that prevail during a continuous period of time. Clusters were identified on the basis of the HL, OHLC intraday volatility and coefficient of variation calculations from the daily stock market index. To rightly comprehend the factors causing volatility, it is required to study both the clusters of peaks and valleys of volatility. Two categories of clusters have been defined on the basis of the peaks and valleys that is when the volatility was exceptionally high and second the when the volatility was very low. The normal period of time when volatility was not on the extreme ends have not been categorized. Only when volatility is at its extreme level, it becomes imperative to study the reasons for such a behavior.

Category I: with peak (high) volatility, the clusters identified on the basis of HL intraday volatility values greater than 0.3 were marked, for OHLC values greater than 0.1 were marked and for coefficient of variation above 1.0

⁵ Gervais, S., & Odean, T. (2001). Learning to be overconfident. *The Review of Financial Studies*, 14, 1-27.
<http://dx.doi.org/10.1093/rfs/14.1.1>

⁶ McQueen, G., Pinegar, M. and Thorley, S. (1996) 'Delayed reaction to good news and the cross-autocorrelation of portfolio returns', *The Journal of Finance*, 51(3), p. 889. doi:10.2307/2329226.

was marked. From this three major clusters were identified: Peak cluster I-1991-1993, Peak cluster II-1998-2001 and Peak cluster III -2006-2009.

Category II: with valleys (low) coefficient of variation was identified as Valley cluster IV-1995-1996, Valley cluster V-2002-2003 and Valley cluster VI-2012-2013.

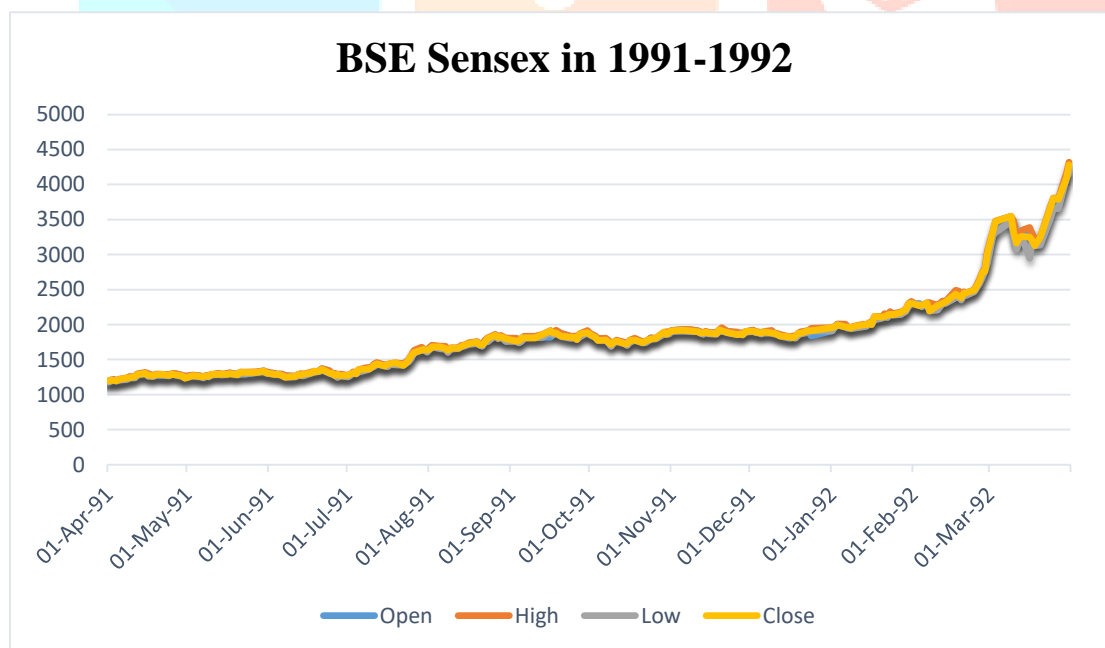
Clusters Analysis:

(i) Peak Cluster I- 1991-1993: In Peak cluster I the Coefficient of Variation started accelerating from 0.88 percent to 1.06 percent during 1992-1993 and the average daily returns dipping from 0.259 to (-)0.144.

a. Significant Events of Cluster I: The major events that marked this cluster were:

- 1991 ushered in the economic and financial reforms in the country, known as the Liberalization, Privatization and Globalization.
- In 1992 market fell in April after a huge scam led by the infamous Harshad Mehta, volatility remained very high and returns dipped to low yield during 1992-93, in the negatives.

Figure 1: BSE Sensex plot 1991- 1992



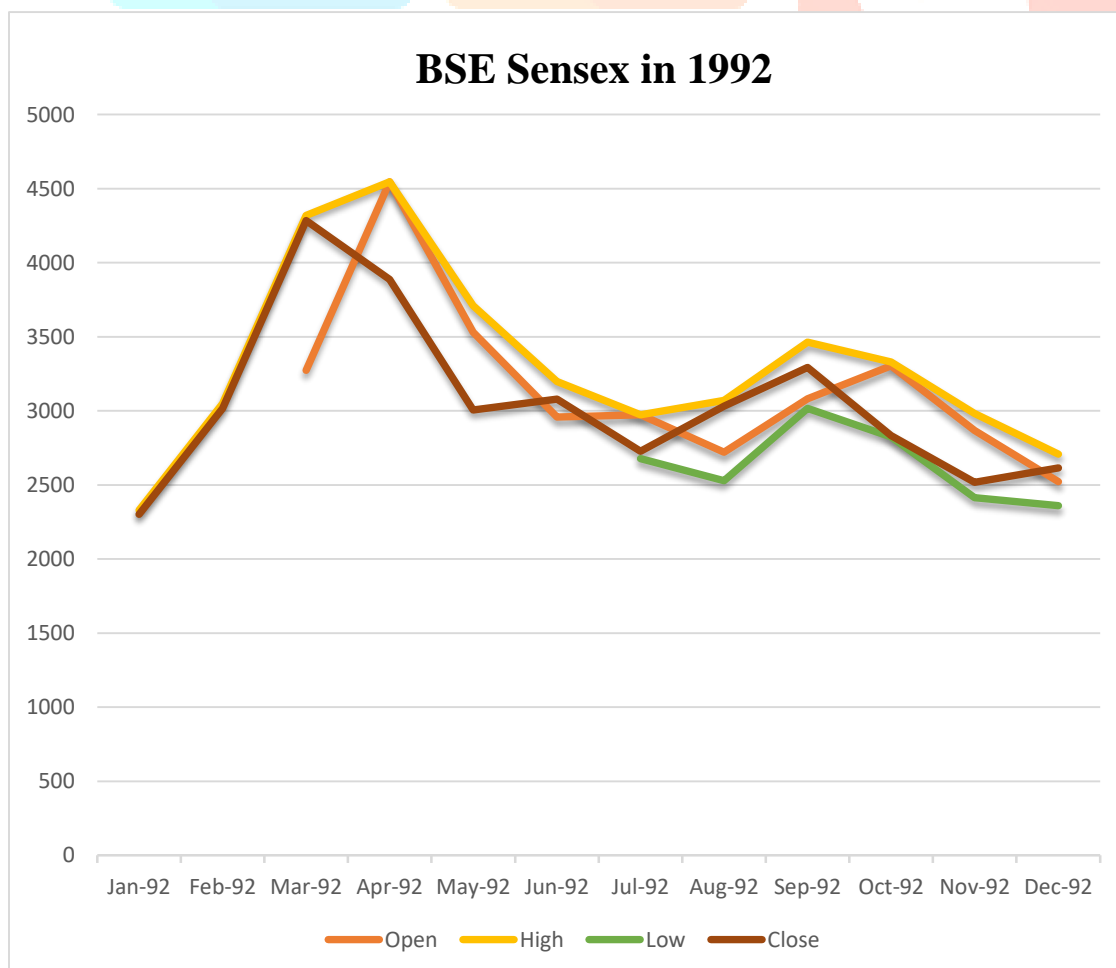
Source: BSE Ltd. Historic Daily Indices, BSE Ltd.

b. Scenario in the Indian Stock Market:

As the volatility increases the returns get lowered as found from the analysis in intraday stock market volatility and daily stock returns. 1991-1993 was marked with high volatility in the high low intraday volatility. It was beginning of the reform era. The stock market moved from 1000 points in 1991 to almost 4500 points in 1992, just within a period of one year. Figure 1 shows the BSE Sensex reflecting increase in the index from 1000 points to 4000 plus points in March 1992, showing growth in the economy reflected by the growth in the index of the stock market. Thus the policy changes and reforms brought in the country had a positive effect on the stock market.

Refer to Figure 2 for daily Sensex plot in 1992. After 23rd April 1992 when news broke about huge embezzlement, market dipped and remained low for 1992-93, the volatility was very high and many people lost money as returns went into minuses (returns reflected in figure 6.1 along with the volatility). After touching 4500 mark in March – April 1992 Sensex remained bearish and had hard time moving even close to 3500 points mark.

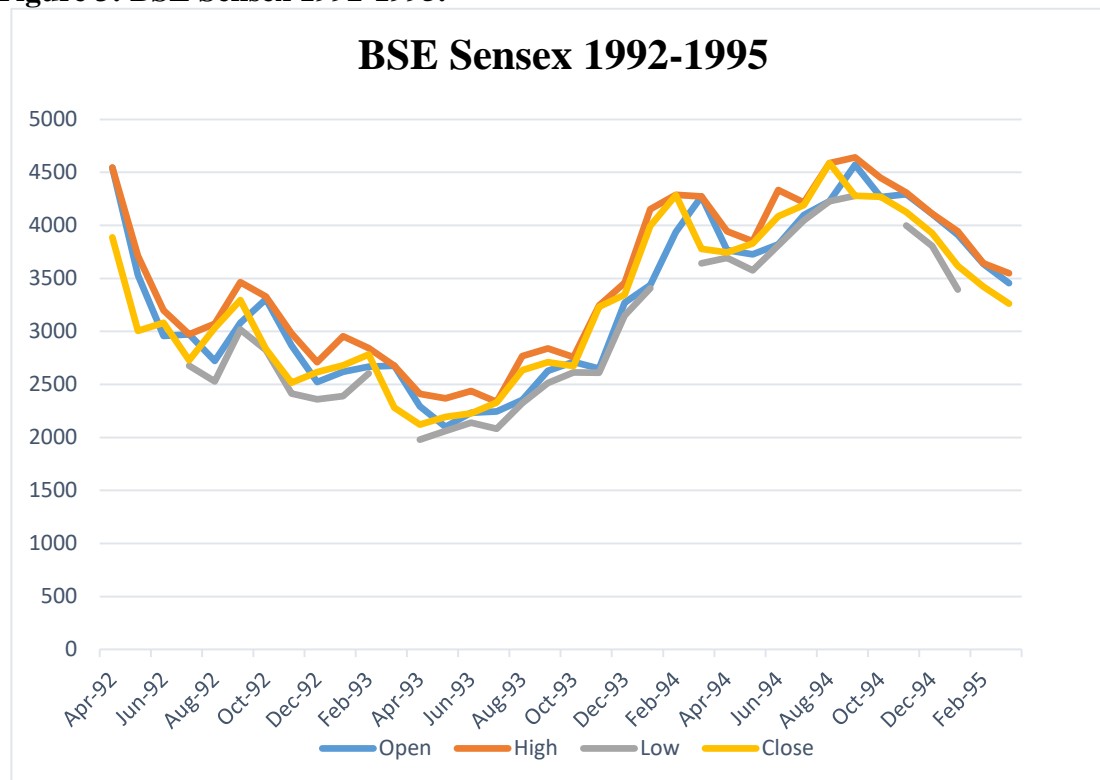
Figure 2: BSE Sensex plot 1992



Source: BSE Ltd. Historic Daily Indices, BSE Ltd.

Figure 3 shows the plot of the BSE Sensex daily index from 1992 to 1995 reflecting a very volatile period of fluctuations. The returns were very low but stability started setting in from 1995 in the stock market.

Figure 3: BSE Sensex 1992-1995.



Source: Daily historic indices, BSE Ltd.

c. Macroeconomic Condition: Though at the same time economic reforms had been ushered in and the effect of it could be seen in the industry and GDP as a whole.

- GDP moved up from 1.43 to 5.36
- IIP from 0.6 to 2.3,
- Inflation had reduced from 13.07 to 8 percent reflecting slowly stabilization of economy.

Here the volatility in the stock market was more owing to the news of scam followed by fear, distrust and uncertainty in the market.

By 1995-1997, volatility had reduced with Coefficient of variation (C.V.) at 0.1481, as the economy had stabilized with its confidence increasing in the reforms, the macroeconomic indicators were also showing positive vibes with GDP growth rate crossing 7 percent mark and 13 percent of IIP.

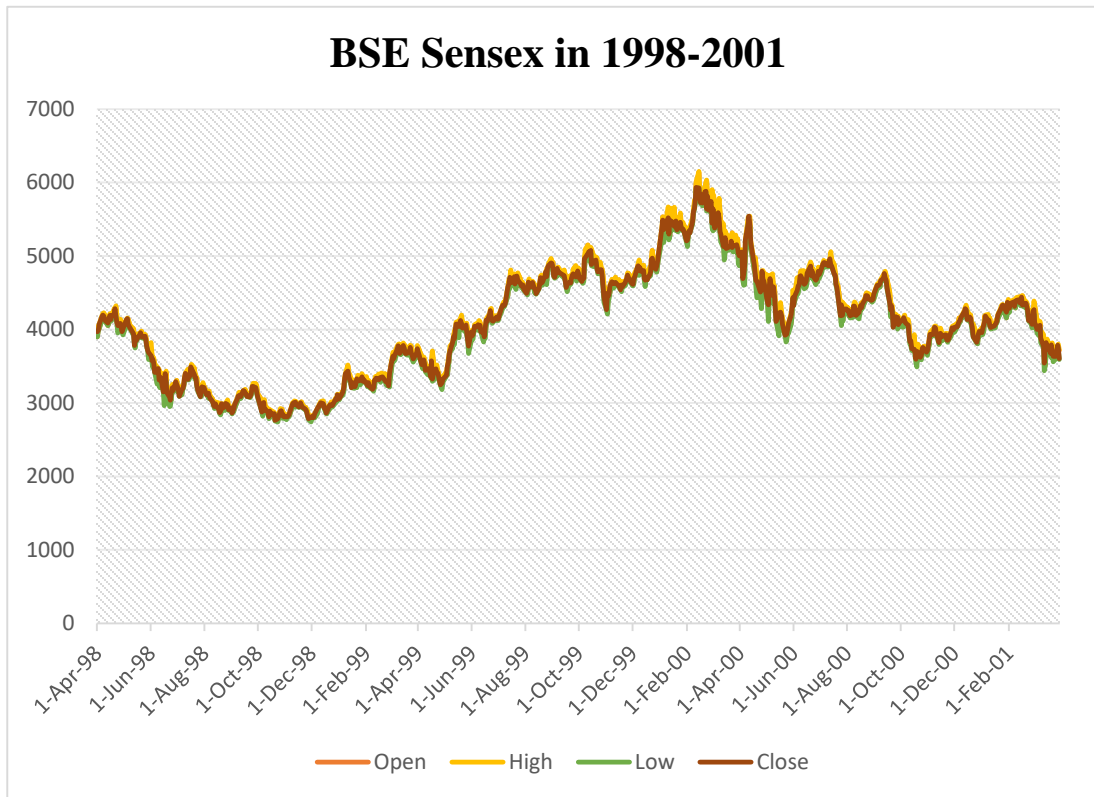
(ii.) Peak Cluster II- 1998-2001: The peak cluster II was identified by C.V. of 1.08 to 1.27 percent variations which is extremely high. The average daily returns dipped as low as (-)0.007 to (-)0.005.

a. Significant Events of Cluster II: The major events that marked this cluster were:

- The first cause of high volatility was the nuclear test in May 1998 leading to imposition of economic sanctions on India by number of western countries including US and Japan, the effect of which could be felt even in 2000.
- The second major cause of uncertainty in stock market was because of the Kargil conflict in first week of May 1999, which affected the government budget and fiscal position as excess allocation had to be made in the defense expenditure.
- The third cause that triggered volatility was the high volatility in the international oil prices resulting in almost all commodity prices to escalate and the oil companies being forced to pay greater exchequer for their imports.
- The fourth cause was the earthquake in Gujarat in January 2001 which put pressure on the government and RBI.

b. Macroeconomic Condition: The macroeconomic indicators were reflecting moderation in the economy:

- volatility went very high with average daily coefficient of variation of Sensex going to 1.27 percent,

Figure 4 BSE Sensex 1998-2001

Source: Daily Historic Indices, BSE Ltd.

- growth rate of industries increased to 6.03 percent,
- imports reduced to 4.6 percent and exports increased to 21.1 percent.
- bank deposits increased to 18.4 percent from 13.9 percent, reflecting distrust in the prospects of the securities market.
- the agriculture sector having tough time with (-)0.61 growth rate,
- GDP decelerating to 4.3 percent from 7.59 percent and
- highest volatility in inflation with CPI at 3.7 and WPI at an all-time high of 7.2 percent.
- foreign exchange rates where dollar crossed 42 mark by 2000-2001.

c. Scenario in the Indian Stock Market:

- primary market was also subdued and issues were undersubscribed.
- sharp decline in total market capitalization, turnover and trading activity. BSE Sensex fell sharply from 5001 as on March 31, 2000 to 3604 as on March 30, 2001, registering a decline of 28 percent.

- volatility in securities market was on the higher side during the months of April to August 2000 and thereafter it showed noticeable declining trend.(ref. Figure 4)
- number of companies traded during 2000-2001 showed discouraging trend as it declined from 2713 in April 2001 to 2416 as on end October 2001 forming just 27 percent of the total companies listed as compared to 41 percent in the same month in 1999-2000.
- net FII investment was \$2158.80 million as compared to \$2339.10 in 1999-2000, which showed a decline of 7.7 percent⁷.

All the stock exchanges except China registered decline in the stock prices. Nasdaq of USA, Taiwan Weighted Index, the Korean Composite Index, Nikkei 225 of Japan and Kuala Lumpur Composite Index of Malaysia registered much larger decline than the BSE Sensex. In almost all the major securities market across the world, volatility in stock prices was higher by and large in 2000-2001 than that noticed during the previous year, though it showed receding trends towards the end of the year.

Therefore the volatility in 1998-2001 was more triggered as a global phenomenon and bearish sentiments of the investors than the domestic factors. The domestic macroeconomic indicators were only reflecting the contagion effect of what was happening around the world in the developed markets.

(iii.) Peak Cluster III- 2006-2009: In peak cluster III C.V. accelerated from 1.00 percent to 1.51 percent and the average daily returns reduced from 0.02 to (-)0.08.

a. Significant Events of Cluster III: The major events that marked this cluster were:

- Moderation of the economic activity in the US since the second half of 2006 due to offset by the acceleration of activity in the euro area and Japan.
- Headline inflation crossed target/comfort zones in major countries many central banks pursued monetary tightening to contain inflationary expectations.

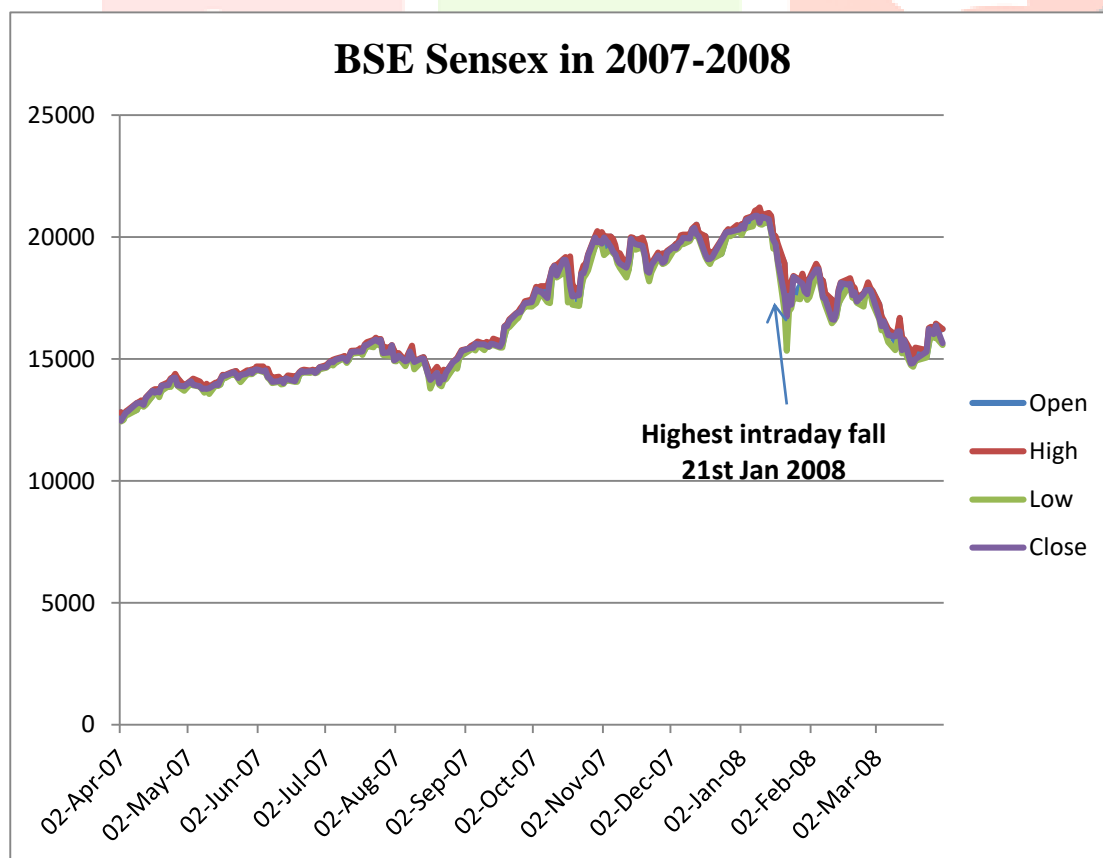
⁷ Source: Annual Report 2000-2001, SEBI.

- The world dipped into recession in 2007. India had a lagged contagion effect due to the strong economic fundamentals and monetary & fiscal policies that served as a cushion for its sustainability. The effects of it became more visible in the succeeding years.

a. Scenario in the Indian Stock Market:

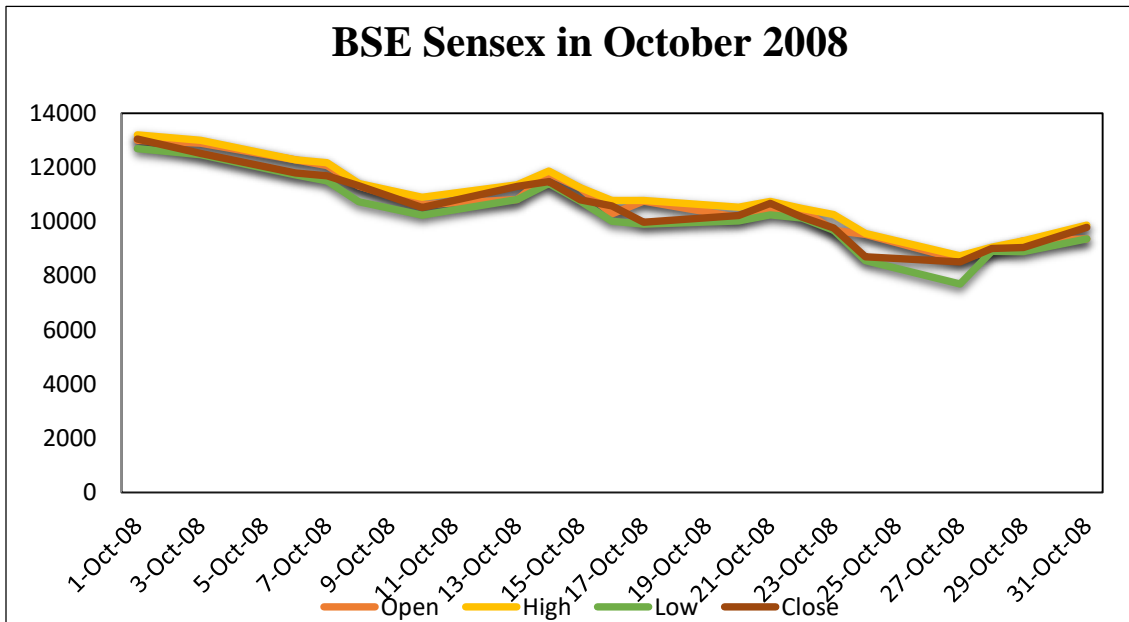
- In 2007-2008 the coefficient of variation for volatility was 1.03 but it increased to 1.5 percent in the following year; the returns in 2007-2008 was 0.031 but it dipped to as low as (-)0.085 in the next year reflecting high volatility and low returns in this cluster.
- The Indian security markets witnessed significant uptrend and volatility in 2007-08. The equity markets registered gains and benchmark index breached historic highs on several occasions in 2007-2008.
- The financial year 2007-2008 commenced with an uptrend in the equity markets (Figure 5). The BSE Sensex crossed the level of 14000 in April 2007. Thereafter markets displayed strength in the first quarter on account of liquidity support from FIIs and Mutual funds and strong corporate profitability. During the second quarter the buoyant trend continued with corrections in between.

Figure 5 BSE Sensex in 2007-2008



Source: Daily historic indices, BSE Ltd.

- In January 21, 2008, the markets recorded highest intraday correction in the Indian equity market(refer Figure 5); the months of October 2007 and January 2008 witnessed higher volatility as compared to other markets Indian indices were one of the highly volatile indices in the world during January 2008.
- The annualized volatility of BSE Sensex was 30.6 percent during 2007-2008. Since mid-January 2008, stock markets witnessed sharp corrections in tandem with the global equity markets.
- Apart from the growth factors, benign inflation rate and upward trend in the global equity markets supported the market.
- US sub-prime mortgage crisis, surge in international crude oil prices, political uncertainty were the cause of volatility.
- The end of 2007 showed decline in the developed equity markets due to subprime losses, fear of credit squeeze and global recession which led to decline in the Indian equity markets.
- The depreciation of the US dollar against major currencies and increase in global crude oil prices to high levels also contributed to decline in the equity markets.
- Resources raised by the corporates from the primary market were substantially higher indicating the continuation of investment boom in India.
- Sound domestic fundamentals, private corporate profitability and active buying support from institutional investors were the major factors that dominated stock market movement during 2007-2008.
- Stock prices were volatile particularly in the month of October 2008 when the global meltdown was at its peak (refer Figure 6).

Figure 6 BSE Sensex in October 2008 during global meltdown

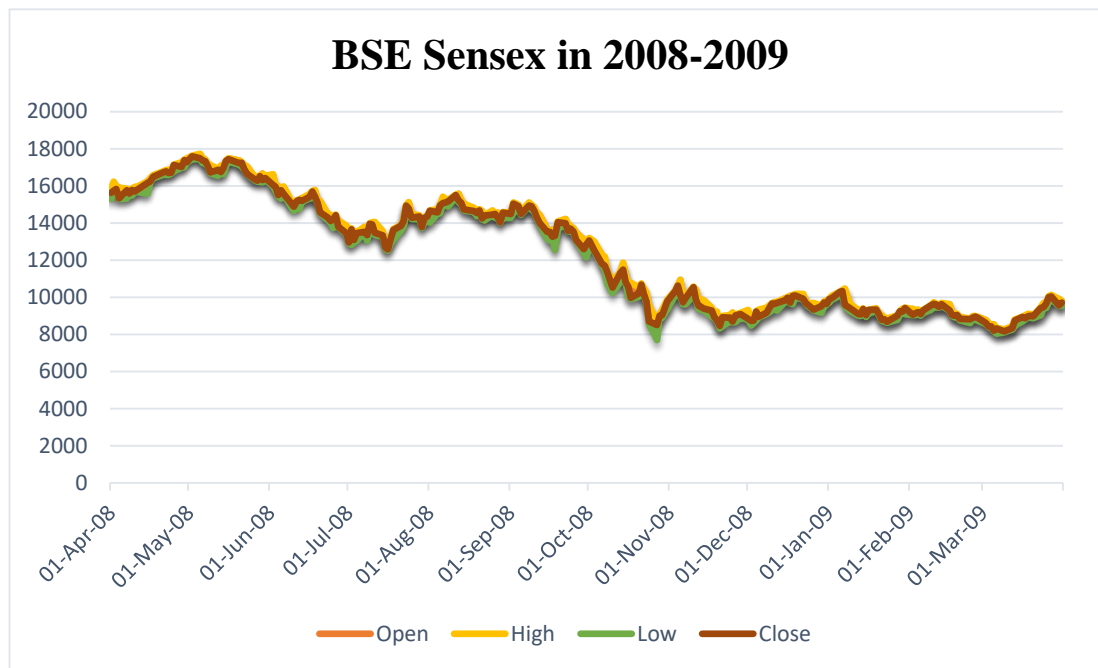
Source: Daily historic indices, BSE Ltd.

a. **Macroeconomic Condition:** The macroeconomic indicators reflected recession in the economy:

- GDP in 2007-2008 was above 9 percent and the effect of global recession was seen in 2008-2009 with GDP lowering to 6.7 percent and IIP following the same pattern.
- Imports and exports improved in 2007-2008 that is 35.1 and 28.9 percent respectively than previous year, leading to strengthening of Indian currency.
- But the liquidity conditions tightened in 2008-2009 as rising bank credit, higher forex demand from importers and rise in global oil prices besides outflows by foreign institutional investors.
- 2008-2013 inflationary conditions were seen in the market, with the government trying its best to tame inflation.
- In 2007-2008, total FDI investment jumped from \$29,829 million to \$62,106 million. India being the attractive place to invest, had a huge investment gain by foreign investors during this time.
 - ◆ portfolio investment went up almost 4 times from \$7003 million to \$27,271 million and FII investment escalated to 7 times from \$3,225 million to \$20,328 million and offshore investment to whopping 149 times that is \$2 million to \$298 million.

- ◆ This shows the reason why in 2007-2008 India did not feel the shock of global recession immediately but looking into the next year that is 2008-2009 it shows FDI pulled out thus affecting stock market volatility during that cluster (refer Figure 7).

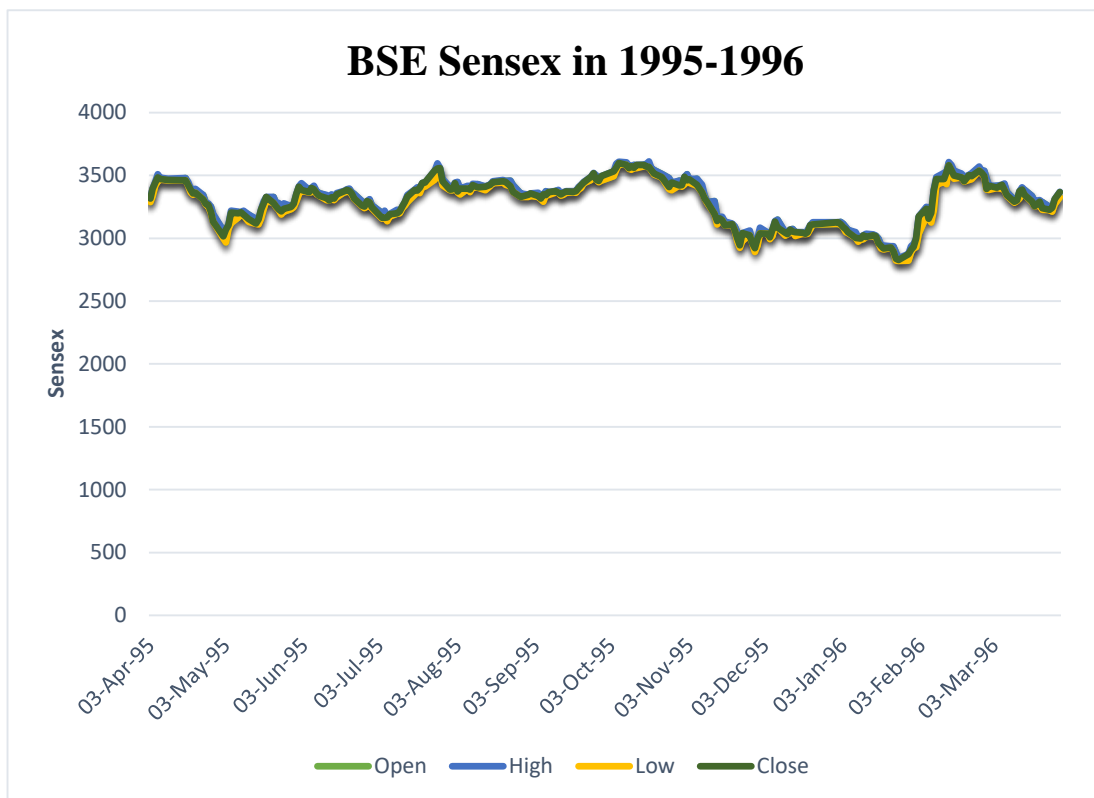
Figure 7 BSE Sensex in 2008-2009



Source: Daily historic indices, BSE Ltd.

Category II: Valley clusters are those when the instability and uncertainty in the market was less. Mostly because of the strong macro-economic conditions. Valley clusters are marked with less stock market volatility that is a reflection of stability in the market.

(iv).Valley Cluster IV- 1995-96 : In the valley cluster IV, C.V. was very low that is 0.14 percent and average daily return was 0.005. Refer Figure 8, the BSE Sensex shows a consistent pattern between 3000 to 3500 points and less variability. This is a mark of stability in the stock market. The lowest intraday volatility is registered during 1995 and then onwards it continuously increased till 2000 and then started falling.

Figure 8: BSE Sensex 1995-1996

Source: Daily historic indices, BSE Ltd.

a. Macroeconomic Conditions:

- GDP rate persisted to 6.2%, gross domestic invested increased 25.7%
- Rate of growth for industrial production 12 percent reflected the effect of new industrial policy and of economic liberalization
- Export growth in dollar terms were at 24 percent and current account deficit declined and was at 1.5 percent of GDP
- Inflation dipped on average basis was 7.7%
- Portfolio investment was strong on account of investments by foreign institutional investors.

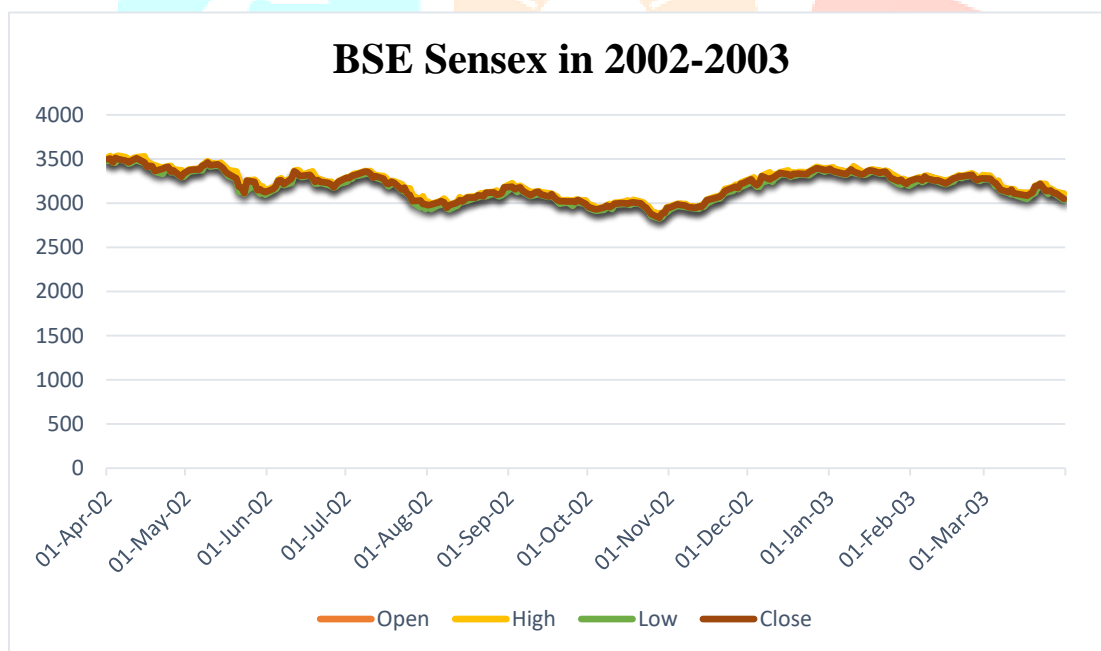
Greater stability and low volatility was seen in this cluster because of the strong macroeconomic variables and consistent growth in the economy.

(vi). **Valley Cluster V- 2002-2003:** In valley cluster V, the C.V. was 0.63 percent and daily returns were low (-)0.022.

a. Stock Market Scenario:

- The returns were negative, lesser number of IPOs were in this period.
- SEBI reported that the fall in the market was not in India alone but a global phenomena⁸.
- Amount of funds mobilized in the primary market was significantly up.
- Prevailing domestic and international industrial market, excess capacities and globalization are the few factors responsible for the lack luster performance of the primary market.
- The close to close volatility (refer Figure 9) recorded during 2002 was lowest since 1995.

Figure 9: BSE Sensex in 2002-2003



Source: Daily historic indices, BSE Ltd.

- The 2002 year open to open daily volatility was lowest since 1991.
- Sensex reflected volatility decline over the months, as per the SEBI report structural changes such as introduction of derivative products, rolling settlement, banning of deferral products etc. contributed to this fall.

⁸ SEBI Annual Report 2002-2003.

Sensex reflected volatility decline over the months, as per the SEBI report structural changes such as introduction of derivative products, rolling settlement, etc. contributed to this fall. **(vi). Valley Cluster VI- 2012-2013:** In valley cluster VI, the C.V. was 0.76 and daily returns were (-)0.019. After the setback of the 2011-12, early 2012-13 marked the more pronounced deterioration of the global economic activity. But the setback in the global economic activity had a lagged effect on the Indian stock market. The stock market remained stable and showed low volatility though the returns were negative.

a. Macroeconomic Variables:

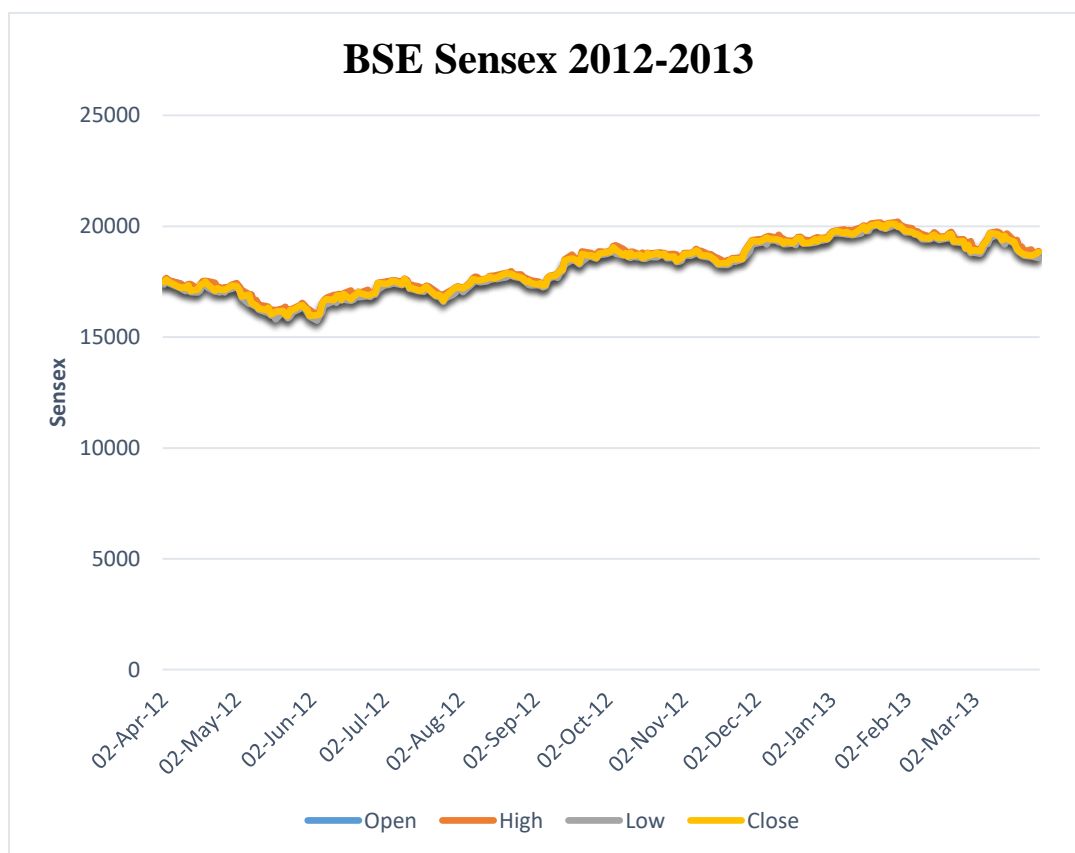
- While investment dipped but consumption picked up slowly in advanced economies and steadily in the emerging economies.
- Financial markets boosted the economic activity and the broad markets have rallied in the 2012-13.
- Rate cuts have been induced to combat slowdown by RBI.
- Growth rate declined in 2011-12 to 6.2 percent which continued to recede to 5.0 percent in 2012-13.
- Global financial woes and domestic concerns seem to have dampened the economic expansion in 2012-13.
- IIP showed sluggish growth of mere 1.0 percent in 2012-13 as compared with 2.9 percent in 2011-12.
- Service sector has over a decade remained at the forefront of India's growth rate. Its share in the GDP has risen from 65.2 percent in 2010-11 to 66.3 percent in 2011-12 and further to 67.4 percent in 2012-13.
- CPI index was at 10.4 percent compared to 9.4 percent in the previous year.
- The exchange rate declined to Rs 54.39 per USD on March 28, 2013, depreciating 6.32 percent over March 30, 2012 when the rates was 51.16 per USD which was a further decrease from 44.65 per USD in March 31, 2011. The average value of rupee per USD touched an all time low of 57.22 on June 27, 2012.

b. Scenario in the Indian Stock Market:

- The sensdex closed at 17,404 on March 30, 2012 reached 18,836 as on March 28, 2013. It touched the 20,000 mark during the year. (refer Figure 10)
- Sensdex registered a growth of 8.2 percent.
- The market capitalisation of BSE stood at Rs 63,87,887 at the end of March 2013 compared to Rs 62,14,941 at the end of March 2012 while its ratio to GDP stood at 63.7 percent for 2012-13.

- The stock prices in 2012-13 (refer Figure 10) started on a low note carrying forward the fluctuations of the previous year but the sensex saw new heights and achieving the pre crisis levels.
- The foreign investments contributed by FII and FDI own assets under custody valued at Rs 15,77,288 crore for 2012-13 up from Rs 13,39,240 crore in 2011-12.

Figure 10: BSE Sensex in 2012-2013



Source: Daily historic indices, BSE Ltd.

- Resources mobilised in the primary market have risen by 20 percent in the wake of the renewed fervour. A total of Rs15,474 crore of equity capital has been raised in 2012-13 through 49 issues compared with Rs12,857 crore raised through 51 issues in 2011-12.

The stability in the stock volatility in this cluster was due to the stable economic environment and then the confidence of the investors in the market.

Conclusion:

After studying the clusters it is found that both persistent and non-persistent macroeconomic factors in different clusters affect with time variability. In some clusters macroeconomic factors does not necessarily explain the stock market volatility dynamics. Stock market volatility is explained in some clusters by the significant events that occurred during that period. The peak clusters displaying high volatility were all due to different reasons. The first peak cluster though having high volatility showed positive signs of economic reformation. Although volatility was caused because of scam, during the same period establishment of SEBI marked the building of strong security and vigilance system for the stock market. The second cluster was caused by number of events taking place affecting the macroeconomic fundamentals of the economy which was soon controlled with the proper policy and growth initiatives of the government. The third peak cluster was the lagged effect of the global economic recession. The valley clusters were marked by the growth in the economy resulting in the stability in the stock market.

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