CHAPTER 8

CONCLUSION

8.1 Summary

Employing agent based ASM and studying the behavior of market participants of BSE, this dissertation focuses on analyzing the reasons for the prevailing high volatility in the BSE. The necessity of introduction of a market maker for possible regulation of volatility in the BSE has been a significant outcome of this research work. A model of a market maker has been proposed. Agent-based computational approach has been chosen as a tool for studying the behavior of market participants at the BSE, since it gives the freedom to manage various parameters, and the possibility to observe traders’ behavior. Using intelligent agents, the behavior of market participants has been modeled in terms of algorithms which helped to study the influence of traders’ decision on the dynamics providing a valuable link between micro and macro behavior of the market.

Since an agent based simulation constitutes a bottom up approach, a realistic description of the behavior of the market participants would have to be evolved. In Chapter 2, an overview is given on the structure of stock market organizations, the behavior of market participants and the relevant factors of a stock market that should be considered for its analysis have been identified. The literature on market microstructure was studied to understand market dynamics and arrive at a realistic model of the market depicting the market organizations and dynamics. The aspects analysed were: the possible route of orders in different market organizations; organizational factors and aspects related to price formation and traders’ behavior; approaches and theories about market dynamics; aspects of investor behavior viz overconfidence, sentiments (pessimism and optimism), self-attribution bias, recency and primacy effects. The structure prevalent in the BSE was explored next. The trading behavior of market participants, such as investors, brokers and market-makers resulted in taxonomy of real markets and market participants.

In Chapter 3, a survey is carried out on several ASM from the literature. The aspects that these ASM represent and model are investigated. ASM are able to link individual investor behavior and financial market dynamics. They are often computational models, usually comprised of a number of heterogeneous and boundedly rational agents, which interact
through some trading mechanism, while possibly learning and evolving. These models serve the purpose of studying agents’ behavior, price discovery mechanisms, the influence of market microstructure, or the reproduction of the stylized facts of real-world financial time-series. Traders are represented as individuals and macro features emerge from individual interaction and prices are endogenously formed by the system itself as the result of interaction of market participants. By using agents for studying market dynamics, heterogeneous, boundedly rational, and adaptive behavior of market participants are represented and its impact on market dynamics assessed. The model proposed by LeBaron [63] was inferred to be a suitable model to represent the BSE.

In Chapter 4, a survey is carried out on those ASM that model behavior bias of investors. Agent-based artificial financial markets are potentially able to fully bridge the gap between individual investor behavior bias and aggregate market phenomena, by allowing the modeler to specify the behavior of market participants, to implement various market mechanisms, and to analyze the resulting asset prices [71, 75]. Investor sentiment, investor overconfidence, recency and primacy effects, self-attribution bias etc could be studied when suitably incorporated in the modified LLS model. The overconfidence in the model referred to the narrow bands of the return distribution around the mean of return observations, while sentiment in the model determined how that mean is chosen. The modified LLS model proposed by Lovric M. [75] was seen to be intuitively appealing and hence appeared to be a reasonable choice to study behavioral bias of investors in the BSE.

In Chapter 5, LeBaron’s ASM model chosen to model the BSE in Chapter 3, was run with forward testing, i.e., by taking as input the actual data from the BSE, so as to explore the aspects of volatility prevailing in Indian markets. It has been demonstrated that the volatility as existing presently would persist, suggesting that it is indeed the interaction between agents of different strategies that brings volatility and trading in the market. In order to bring about stability (thereby a “Healthy” volatility), it is imperative that the financial structure of the BSE is revisited. A possible solution is the introduction of market-makers, as is prevalent in the more mature markets.

In Chapter 6, employing the modified LLS model (inferred to be a suitable model to study behavioral biases in Chapter 4), the behavior of various categories of fundamental, technical and uninformed investors populating the BSE is analysed, and an attempt is made to arrive at a possible proportion of their distribution, which may also explain the causes for the high volatility prevalent. The behavioral aspects of sentiments, overconfidence, self attribution
bias etc are built into the model and important conclusions have been drawn. It has been demonstrated that the technical investors dominate the market (85%), which is a plausible explanation for the prevalence of high volatility in BSE. This conclusion has been strengthened by the result obtained experimenting with NYSE and NASDAQ stock exchange data. It was seen that the fundamental investors dominate both these markets with over 75% representation. This perhaps explains the reason as to why these developed markets exhibit “maturity” and “healthy” volatility. The study demonstrated the need for initiating structural changes in the BSE, by way of introduction of market makers for possible regulation of the prevailing volatility observed in BSE, in the sense that the market price perturbations are in direction with the intrinsic value.

In Chapter 7, the role of a market-maker is studied; the important models are discussed and the effect of introduction of a market maker in the BSE to regulate the volatility is analyzed. Absence of an electronic market maker in the Indian markets is perhaps one of the key reasons for the prevailing high volatility. It has been illustrated in Chapter 7, that introduction of market makers in the Indian markets can bring about regulation of volatility. There are two main approaches to the market-making problem: one focuses on the uncertainties of an order flow and the inventory holding risk of a market-maker, and the second employs role of information wherein the market-maker makes inferences from the orders and sets the quotes. This informational disadvantage is reflected in the bid-ask spread. For the market making in BSE, information based strategy based on the Extended Glosten and Milgrom Model proposed by Das [25,26] has been adopted and implemented employing data from the BSE. Graham’s Intrinsic Value is considered as the fundamental value of an index/stock, and using the strategy in EGM, the market maker’s bid-ask prices are evaluated. The results show that the quote of the market maker closely reflects the fundamental/ intrinsic value of stocks. The reduced variance of the market maker’s quote from the fundamental value, vis-a-vis that of the market value of the stock demonstrated that the suggested strategy can regulate volatility in the BSE. Also, by giving two way quotes, the aspect of illiquidity of stocks can be handled.

8.2 Contributions of the Thesis

The main objective of this work is to analyse the reasons for the prevailing volatility in the Indian stock market and suggest measures to restore healthy volatility. The behavior of the market participants in the BSE is analysed employing suitable agent based ASM so as to evolve an explanatory model which would enable the study of influence of traders’ decision
on the market dynamics. Further, the role of market maker in the BSE is studied for possible regulation of volatility in the BSE. Agent based computational approach is employed for the study. Some of the significant contributions of this work are highlighted below:-

(a) **An ASM Model to Represent the BSE.** A demonstrated application of an ASM, to quantitatively replicate various features of an actual financial market (BSE) has been presented. An ASM model developed exclusively for the BSE is not reported thus far. A number of agent based ASM models proposed by researchers, primarily dealt with US markets, whereas, no such work has been seen published for the BSE.

(b) **Forward Testing the BSE for Volatility Analysis.** Forward testing (by taking as input the actual data from the BSE) on the model so chosen, various statistical properties of the BSE have been arrived at. It has been demonstrated that the volatility as existing presently would persist in the BSE, suggesting that it is the interaction between agents of different strategies that brings volatility and trading in the market.

(c) **ASM: Linking Micro and Macro Behavior of the BSE.** Demonstrated that agent based ASM can contribute to provide the link between micro and macro behavior of the BSE. The behavior of various categories of fundamental, technical and uninformed investors populating the BSE is analysed for the first time using an agent based model. The dynamics of investor interaction in BSE has been studied using the selected modified LLS model.

(d) **Behavioral Bias Model of BSE.** The behavioral aspects of sentiments, overconfidence, self attribution bias etc are built into the model of the BSE with mathematical representations and important conclusions have been drawn (Chapter 6 refers).

(e) **Preponderance of Technical Investors in the BSE and their Effect on Volatility.** It has been demonstrated that technical investors (85%) dominate the Indian stock market. The prevalence of high volatility in BSE is inferred to be due to the disproportionate higher presence of technical investors populating the Indian stock market.

(f) **Domination of US Stock Markets by Fundamental Investors.** The results obtained experimenting with NYSE and NASDAQ stock exchange data showed that the fundamental investors dominate both these markets with over 75% representation. This perhaps explains the reason as to why these developed markets exhibit “maturity” and “healthy” volatility.
(g) **Introduction of Market Makers to Regulate Volatility in the BSE.** Consequently, the study demonstrated analytically the need for initiating structural changes in the BSE, by way of introduction of market makers for possible regulation of the prevailing volatility observed in BSE, in the sense that the market price perturbations are in direction with the intrinsic value.

(h) **Recommended Market Maker Model for the BSE.** A suitable market maker model for the BSE has been proposed. Information based strategy based on the Extended Glosten and Milgrom Model proposed by Das [25,26], has been suggested for market making. The results showed that the quote of the market maker closely reflected the fundamental/ intrinsic value of stocks. The reduced variance of the market maker’s quote from the fundamental value, vis-a-vis that of the market value of the stock demonstrated that the suggested market making strategy can indeed regulate volatility in the BSE.

(i) **Dealing with Illiquid Stocks in BSE.** In the proposed market making strategy, the aspect of illiquidity of stocks in the BSE can also be addressed, by way of giving two way quotes.

### 8.3 Scope for Further Work

(a) **Market Dynamics.** Research in the field of market dynamics can be conducted in many directions, due to the fact that market dynamics are still difficult to understand, and that many varying market organizations and hardly observable aspects of price formation and traders’ behavior exist. Therefore new ASM can be developed to include other important aspects that differentiate various stock markets within India and also outside the country.

(b) **ASM.** In the thesis, only some representative ASM have been surveyed and compared - this list can be extended. Also, multiple stocks could be considered, and investors could be modeled as portfolio managers in multiple stocks.

(c) **Market Makers and Brokers.** More market makers could operate on the same market, and the behavior of brokers could be incorporated. Market maker’s learning behaviour under different circumstances (interference from government of the day, cartelism, influx and withdrawal by FIIs, acts of God etc) can be investigated.

(d) **Multiple Environments.** Another challenging application of the environment is to run it in a distributed way with more types of markets running simultaneously.
trading in similar stocks, and observe the behavior of traders who exploit differences in pricing. Experiments with a higher number of individual traders would make the results more valuable as well.

(e) Development of Flexible Research Toolkits. Agent-based research methodology should be seen as a complementary methodology to other approaches for studying behavioral finance topics, such as experiments and empirical research. In order to make this possible, it is important to develop flexible toolkits that will enable easy construction of agent based models as well as easy implementation of agent behaviour. Specialized toolkits should provide additional features which are specific to artificial markets, such as the choice of various market mechanisms, as attempted by Boer [8]. Since the results can vary depending on the mathematical model used, the outcome of different models incorporating the same behaviour bias discussed in the work with different market mechanisms could be compared.

(f) Validation. The agent-based models could also be validated by using the experimental measurements of behavioral biases and parametric values that represent them.

(g) Refine Mathematical Computational Models. For refining the mathematical formulations, fuzzy logic and its ability to express expert knowledge could be useful.

(h) BSE Data. For analysis of market behavior, a stock with beta close to one has been chosen. This limitation could be removed by considering all the stocks in the basket of SENSEX.

(i) Comparison with NSE. The study could be extended to NSE as well and appropriate lessons drawn, for instance on the importance of market makers.

(j) Behavioral Bias. Peculiar characteristics of Indian investors can be further addressed, for instance, the equity cult is still at a nascent stage and the penetration is limited to the population in the urban areas.

(k) Online Trading. A study on behavior of investors who resort to online trading is likely to show interesting results.

(l) Composition of Investor Categories in other Stock Markets. This study can be enhanced to analyse the composition of traders in various other stock markets of the world.
(m) **Influence of Institutional Investors.** Institutional investors like LIC, nationalized banks, pension and provident fund managers are seen to respond to the interests of the Indian Government. The huge investments involved would imbalance the market price mechanism and hence their role merits investigation.

(n) **Availability of Multiple Investment Options.** The simulation models assets available in the capital market, ignoring other investment opportunities and assets such as property, commodities like oil, gold, silver etc. Such multiple investment avenues available to Indian investors could be considered in future work.

(o) **Interpretations of Behavioral Phenomena.** One particular behavioral phenomenon can have multiple definitions and manifestations. Therefore, the relevance of each behavioral phenomenon could be treated further as a research question on its own, and addressed using appropriate techniques, whether empirical, experimental, or as agent-based simulations.

(p) **Intrinsic Value of Stocks.** The intrinsic value of a stock indicates the true value of a particular business and is difficult to determine. While market value records the rise and fall of the stock price in the financial markets, the book value may not reflect the true value of the stock at all. The toughest part of developing an intrinsic value formula is making it “one size fits all” for the purpose of comparing stocks. Intrinsic value of a particular stock is influenced by ephemeral factors like research, brand identity and market psychology. Further, some companies own priceless real estate; some have big investment portfolios; others have surplus cash flow which is ploughed back into the business; others pay all their cash out in dividends; still others eschew dividends entirely and focus on share buybacks, while yet other companies are focused on present sales growth that will hopefully turn into multiple earnings in the future. The dividend discount model (DDM) is a way of valuing a company’s future cash flows based on the theory that a stock is worth the discounted sum of all of its future dividend payments. In other words, it is used to value stocks based on the net present value of the future dividends. The equation most always used is the Gordon growth model [42], which is based on predicting future projections. In this work however, Graham’s Intrinsic Value [43] is used, since it is based on parameters that can be measured practically: earnings, dividends, past growth rates, and current interest rates. Studies with respect to estimates other than Graham’s Intrinsic Values could be undertaken.