Abstract

Volatility is an established phenomenon in emerging markets, and India is no exception. The volatility prevailing in the Indian stock market of Bombay Stock Exchange (BSE) is relatively high when compared to NASDAQ or NYSE in the US. The BSE trading system, which was initially both Order and Quote driven, transformed to only Order driven, wherein the buyers and sellers transact directly with each other. In the NASDAQ and NYSE, market-makers/specialists respectively, play a vital role in their structure in trading, and bring in stability to the market. However, market-makers are absent in the Indian markets, which is perhaps one of the key reasons for the prevailing high volatility.

Stock markets are complex systems; hence models are needed to study their dynamics. Artificial Stock Markets (ASM) are models for studying the link between individual investor behavior and financial market dynamics, enabling the study of agents’ behavior, price discovery mechanisms, the influence of market microstructure, and the reproduction of the stylized facts of real-world financial time-series. Market participants are modeled as evolving systems of autonomous interacting agents that correspond to the trading parties. In ASM models, prices can be endogenously formed by the system itself as the result of interaction of market participants.

This dissertation focuses on evolving an explanatory model to study the behavior patterns of market participants of BSE employing agent based ASM models, and suggests a suitable market making model to regulate the volatility.

A large number of agent based ASM models have been proposed by researchers primarily dealing with US markets, whereas, no such work has been seen published for the BSE. In this study, few well known representative ASM have been analysed to assess their suitability to model the BSE. The model proposed by LeBaron has been inferred to be a suitable model to represent the BSE to study the volatility aspect and empirical regularities; Lovric’s modified
Levy, Levy and Solomon (LLS) model to study investor behavior bias; and the Extended Glosten and Milgrom Model (EGM) for market making.

Employing LeBaron’s model, the market simulation of BSE is done by forward testing the ASM model where the market is run using real data as the price input up to the current date, and then allowed to continue on into its future to enable the study of the empirical features. It has been demonstrated that the behavior of agents with varying trading horizons and strategies induces trading and leads to volatility in the market. The financial data of BSE from the years 2003 to 2009 is considered for building the model, as against LeBaron’s model, where the data is entirely generated.

The behavior bias of investors in the BSE is analysed inspired by the work done by Lovric M. on the LLS model. In this experiment, the ASM model is further modified and adopted to suit the study of BSE. Three categories of investors are modeled, namely: Fundamental Investors (FI), Technical Investors (TI) or Chartists and Uninformed Investors (UI). The choice of utility function is Decreasing Absolute Risk Aversion (DARA) and Constant Relative Risk Aversion (CRRA). In the LLS model, the fundamental investors adopt Gordon’s model, whereas in the model proposed here, Graham’s model has been used. In each period, the fundamental investor chooses the proportion of wealth to invest in stocks and bonds so that the expected utility of wealth is maximized in the next period. The technical investors believe that the price accurately reflects the fundamental value. However, since they do not know the dividend process, they use ex-post distribution of stock returns to estimate the ex-ante distribution. In this model various behavioral characteristics of technical investors viz normal and overconfidence, sentiments (optimism and pessimism), recency and primacy effects, self attribution bias etc have been incorporated. The FI and TI in varying ratio of population were modeled with different confidence levels and memory lengths and the price series generated for various combinations. It has been shown that the technical investors are primarily responsible for the volatility in the BSE. Further, the maximum correlation coefficient between the simulated price series and the BSE market price series between the period 1997 and 2010 occurred for a population of 10% to 15% fundamental investors and 85% to 89% technical investors. This clearly showed that the domination by TI being over 85% is perhaps a plausible explanation for the prevalence of high volatility in the 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.

Consequently, it was demonstrated that the Extended Glosten and Milgrom (EGM) market maker model (an information based model) is a suitable electronic market maker for the BSE. The market maker in the EGM model quotes the bid and ask prices based on the orders placed by the pool of traders. It is shown that in the EGM model, the market maker’s quotes are comparable to the fundamental value of the BSE and any sudden change in the fundamental value (in case of jumps) causes fluctuations in the quotes that are very quickly resolved, thereby bringing stability in the market.

In this work, agent-based computational approach has been chosen as the tool for studying the behavior of market participants, since it gives the freedom to manage various parameters, and the possibility to observe traders’ behavior. Using intelligent agents, the behavior patterns of market participants have 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. 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. It has been shown that the behavior of agents with varying trading horizons (memory) and strategies induces trading and leads to volatility in the BSE. Further, a number of investor behavior phenomena have been represented by mathematical models and their implications on the market by way of aggregate fluctuations of market prices have been demonstrated. The domination of BSE by technical investors, (TI population being over 85%) is a suggestive explanation for the prevalence of high volatility in the BSE. In order to bring about “healthy” volatility, the Extended Glosten and Milgrom (EGM) market maker model is recommended to be introduced in the structure of BSE.