Identifying regime shifts in Indian stock market: A Markov switching approach

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Abstract

Seeking for the existence of bull and bear regimes in the Indian stock market, a two state Markov switching autoregressive model (MS (2)-AR (2)) is used to identify bull and bear market regimes. The model predicts that Indian stock market will remain under bull regime with very high probability compared to bear regime. The results also identify the bear phases during all major global economic crises including recent US sub-prime (2008) and European debt crisis (2010). The paper concludes that the Indian stock market is more sensitive to external shocks implying that there is ample scope of policy interventions.

Keywords: Markov switching model, Stock returns, Regime shifts

JEL Classification: C32, C51

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1. Introduction

It is empirically proved that financial market exhibits upward and downward trends which in common terminology is categorized as bull and bear market. However, there is no clear classification of stock market regimes i.e. bull or bear in the literature but few studies by Fabozzi and Francis (1977), Kim and Zumwalt (1979) and Chen (1982) have defined bull regime on the basis of returns exceeding certain threshold value. The occurrence of these regimes is often attributed to several factors that can be broadly grouped into systematic and non-systematic risks. A bull regime is generally characterized as periods of generalized upward trend (positive returns with low volatility) and bear market corresponds to periods of generalized downward trend (negative returns with considerably high volatility). The identification of regime shifts has great significance in making portfolio allocation strategies and enable policy makers to undertake the timely measures to curb on speculative activities.

Besides these risks, changes in the regime in a stock market can be due to external shocks caused by a shock in another market. The obvious examples are Asian flu (1997), Russian cold (1998), Brazilian fever (1999), NASDAQ rash (2000), Argentinean crisis (2001/02), Sub-prime crisis (2008) and the most recent European Sovereign debt crisis (2010). These incidents had catastrophic impacts on stock market regimes around the world including India and the markets were revived through policy interventions. Keeping this in view, the present study attempts to highlight the dynamics of Indian stock market, in particular, identifying bull and bear regimes in two leading indices viz., NSE-Nifty and BSE-Sensex. We apply a probability based Markov-switching model for returns in which the distribution of returns changes over time, i.e., the time-series tends to be cyclical, for example, due to business cycles or stock market cycles (bull and bear). Markov-switching (MS) models are characterized by transitions between states which are governed by a Markov chain. Our study

uses a Markov regime switching model which jointly characterizes the unobservable bull and bears regimes for stock returns, allows intra-regime dynamics, dating and enables further to model the uncertainty about the market regime to be incorporated into out-of-sample forecasts. These apart, it is empirically proved that stock market reflects behaviour such as sudden jumps and crash and therefore, this study also highlights the significance of the use of non-linear MS-AR model compared to linear AR model in case of Indian stock market.

2. Literature Review

Numerous studies have applied Markov regime switching model in identifying the regime switching behaviour of stock market. The first among these studies is that of Hamilton (1989) who enhanced the model of Goldfeld and Quandt (1973) by allowing the regime shifts in dependent data and developed the Markov switching autoregressive model (MS-AR). Since then, the model has been used extensively to capture the regime switching behaviour in economic and financial time series studies. However, the application of Markov regime switching model in financial econometrics, particularly in identifying the regime shifts, started with the pioneer work of Turner et al. (1989) to capture the regime shifts behaviour in stock market using MS-AR () model. Their study highlighted the usefulness of Markov switching model allowing regime shifts to happen in mean and variance and fitting the data adequately compared to other specifications of Markov regime switching models. Cheu et al. (1994) examined the relationship between stock market returns and stock market volatility using the MS-AR model and concluded that there is nonlinear and asymmetric relationship between returns and volatility. Schaller and Norden (1997) carried out a study similar to the Turner et al. (1989) in several directions and found a strong regime switching behaviour in the stock market returns. Nishiyima (1998) investigated the existence and nature of different regimes in aggregate stock returns of five industrialized countries. His study exhibited regime

shifts in volatility rather than in mean returns in five countries. He concluded that volatility instead of mean returns reveal regime shift behavior in all countries.

Maheu and McCurdy (2000) used the Markov regime switching model to classify the US stock market in two different regimes characterized as high returns–stable-state and low return-volatile-state. Guidolin and Timmerman (2006) applied MS-VAR approach to study the relationship between US returns and bond yields. They concluded that four regimes MS-VAR model is required to capture the time variation in the mean, variance and correlation between stock returns and bond yields. Wang and Theobald (2007) carried out a study using MS with switching–in-mean and variance model to investigate the regime switching volatility in six East Asian emerging markets i.e., Indonesia, Korea, Malaysia, Philippines, Taiwan and Thailand, from 1970 to 2004. They concluded that the markets for Malaysia, Philippines and Taiwan were characterized by two regimes while the markets for Indonesia, Korea and Thailand were characterized by three regimes over the sample period. Ismail and Zaidi (2008) examined the regime shifts behaviour in Malaysian stock market returns using MS-AR model. They implemented the MS-AR framework to capture regime shifts behaviour in both mean and variance in four indices of Bursa Malaysia namely the Composite, Industrial, Property and Financial indices. They successfully captured the regime shifts in each index and concluded in favour of applying nonlinear MS-AR model against linear AR model. Maheu et al. (2009) used Markov switching model in order to identify bull and bear regimes for stock market returns. They used 123 years of daily returns on value weighted index of NYSE, AMEX and NASDAQ and applied various structures of markov model to identify the regime shifts and concluded in favour of application of Markov switching model in indentifying regime shifts.

One of the first attempts using Markov switching model in case of India was by Laha (2006). The study identified the regime switching behaviour of Indian stock market using Hidden Markov models under Bayesian framework to address the problem of detecting and predicting regime switching behaviour. Bhattacharya and Singh (2006) used Markov switching model to explore unbiased expectations and efficient market hypothesis. They concluded that relatively longer time horizon is more effective in eliminating arbitrage opportunities than the short run. Kumar (2006) showed the relationship between stock price and trading volume using Markov Switching Vector Error Correction Model (MS-VECM). Using weekly data, He analysed the joint dynamics of stock price and trading volume and concluded that for the whole of the study period, the adjustment towards long run occurs at different rates under the two different regimes.

It is apparent from the above mentioned studies that there are evidences of regime switching behaviour in stock market which can be better understood by applying non-linear models such as markov regime switching model. In case of Indian stock market, very few studies have been undertaken to address the dynamics of regime shifts. The present study will add value to the existing literature in the following directions. We examine the regime switching behaviour of Indian stock market with dating using daily data. Further, the study examines whether stock market returns are predictable even after accounting for Markov switching behaviour using forecasts of both regimes. The study also tries to compare the dating of both leading indices with prediction of each regime. All these aspects of stock market regime have been largely ignored by the existing studies in the case of India. Rest of the paper is organized as follows. Section 3 outlines the methodology used for investigating the objectives. Section 4 describes the data used for the study. Section 5 reports and analyses the empirical results and section 6 ends with concluding remarks.

3. Methodology

The Markov Switching – Auto Regressive (MS-AR) approach is used in this study. This approach is an extension of the AR () model to the nonlinear case. It assumes the existence of a finite number of states, each of which is being characterized by an AR () model. The Markov switching model assumes that time series may display periodic changes in their observed behavior. Such changes happen through switches in states, where the data generating process and average duration of each state are allowed to differ. Assume that r_t is time-series generated as an autoregression of order p with regime switching-in-mean and variance.

$$r_t - \mu(S_t) = \sum_{i=1}^{p} \phi_i (r_{t-i} - \mu(S_{t-i})) + \sigma^2(S_t)\varepsilon_t \quad \text{.....(1)}$$

Here, mean μ and variance σ^2 of the process depend on the regime at time t, indexed by S_t a discrete variable. ϕ_i is the model parameter and ε_t is an i.i.d N (0,1) random variable. S_t is assumed to be a n-state, first order Markov process, taking the values 1……n with transition probability matrix:

P = $\{ p_{ij} \}$ $\quad i, j = 1, 2.....n;$

Where, $p_{ij} = \Pr[S_t = j \mid S_{t-1} = i]$ with $\sum_{j=1}^{n} p_{ij} = 1$ for all i …… (2)

The state dependent mean and variances are specified as

$$\mu(S_t) = \mu_1 S_{1t} + ... + \mu_n S_{n,t} \quad \text{.....(3)}$$

$$\sigma^2(S_t) = \sigma_1^2 S_{1t} + ... + \sigma_n^2 S_{n,t} \quad \text{.....(4)}$$

Where S_{it} takes the value of one when S_t is equal to i and two otherwise. Then equation (1) can then be written as $r_t = \mu_1 S_{1t} + ... + \mu_n S_{n,t} + \gamma_t$ …… (5)

$$\gamma_t = \sum_{i=1}^{p} \phi i \gamma_{t-i} + (\sigma_1^2 S_{1t} + ... + \sigma_n^2 S_{n,t})\varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Based on equation (2), two state transition probability matrix based on first order Markov process can be represented by

$$\text{Prob}\,[S_t = 1 \mid S_{t-1} = 1] = p_{11}$$

$$\text{Prob}\,[S_t = 2 \mid S_{t-1} = 1] = 1\text{-}p_{11} = p_{12}$$

$$\text{Prob}\,[S_t = 2 \mid S_{t-1} = 2] = p_{22}$$

$$\text{Prob}\,[S_t = 1 \mid S_{t-1} = 2] = 1\text{-}p_{22} = p_{21}$$

$$\text{With } p_{11} + p_{12} = p_{21} + p_{22} = 1$$

In the above algorithm, p_{11} and p_{22} denote the probability of being in regime one, given that the system was in regime one during the previous period, and the probability of being in regime two given that the system was in regime two during the previous period, respectively. Thus 1- p_{11} defines the probability that y_t will change from state 1 in period t-1 to state 2 in period t, and 1- p_{22} defines the probability of shift from state 2 to state1 between times t-1 and t. Thus p_{12} is the probability of going from state 1 to state 2.

Details of the estimation and forecasts algorithms of MS model is well known and can be found in Krolzig (1997, 2001) and Hamilton (1989, 1993a, 1993b, 1994).

4. Data

The daily data of two leading Indian stock market indices viz., NSE-Nifty and BSE-Sensex have been taken for analysis, from 02-07-1997 to 12-11-2010 with total data points of 3303 of BSE-Sensex and 3319 of Nifty-fifty, respectively. It may be noted that in both the markets opening days are not same. Therefore, regime cycles dating are not comparable in one to one manner. But on an average the movements of these two indices could be compared

highlighting major shocks or events. Both the indices are analysed in returns.[2] The main reason for using the daily data is to identify more frequent regime switches in both indices compared to low frequency data. Standard unit root tests (not reported but available upon request) indicate that both data series are stationary.

5. Empirical results

Before applying the markov switching model, one has to decide, (i) the number of regimes, (ii) model specification (changing means, variance and AR dynamics) and (iii) lag order of the AR terms (not necessarily in this order). In practice, the state dimension of an MS model is generally determined, either informally by visual inspection of the data or by statistically sound procedures such as Likelihood ratio (LR) tests (e.g., Hansen 1992 and Garcia 1998) and / or data-dependent model selection criteria (Psaradakis and Spagnolo 2003). However, there are several problems with these approaches: the LR tests do not satisfy the standard regularity conditions under the null hypothesis since some parameters are not identified. Determining the number of regimes based on complexity-penalized likelihood criteria such as the Akaike Information Criteria (AIC), the Hannan-Quin Information Criterion (HQIC) and the Schwarz' Bayesian Information Criterion (SIC) as suggested by Psaradakis and Spagnolo (2003) is also problematic because one has to know, for certain, the AR lag order (and other parameters), as well as the MS model specification simultaneously. Inclusion of too many regimes where they are non-existent would result in spurious regressions and reduced accuracy of parameter estimates and precision of forecasts. To avoid the problems of over and under-fitting the state dimension as well as model misspecification. In this study, we determine the number of states based on the visual inspection of the data without considering information criteria. The choice of number of autoregressive terms are based up on serial

[2] The returns are calculated by $[\{\log(r_t) - \log(r_{t-1})\} * 100]$

correlation present in both stock market series. A two-state Markov regime switching model is applied. The MS (2)-AR (2) model has been estimated by employing the maximum likelihood approach, for both Nifty and BSE-Sensex indices. The process indicated that the strong convergence is achieved. The filtered and smooth probabilities for the two states are obtained after estimation. The estimation results of the BSE-Sensex are presented in table 1.

[Insert table 1 about here]

From table 1, it can be seen that the AR (2) co-efficients are significant. Since regime 1 (S_t =1) exhibits the negative returns with high volatility and S_t =2 indicates the negative returns with low volatility. It implies that state 1 indicates bear regime and state 2 represents bull regime in the estimated results of BSE and NSE. In the regime represented by S_t =1, the average expected return is μ_1 = -0.177 percent per day with high volatility of σ_1^2 = 6.791, while S_t =2, the average growth rate is μ_2 = 0.155 percent per day with low volatility compared to bear regime as σ_2^2 = 1.214. The persistence of each regime is high.[3] The probability that the bear regime will be followed by another day of bear regime is p_{11} = 0.96 and the regime will persist, on average, for 26 days (more than a month). However, the probability that the bull regime will be followed by another day of bull regime is p_{22} = 0.98.This episode will typically persist for 54 days (close to two months). It is interesting to observe that during bear regime the average expected returns is negative with high volatility compared to bull regime. Similarly, the probability that the bear regime will be followed by bull phase is represented by p_{12} = 0.02 and the average persistence of this regime is only 1 day. The probability that the bull will be followed by another day of bear is p_{21} = 0.04 and the average duration of this regime is 1 day. The results of these two regimes unravel the

[3] The persistence of a particular regime is calculated using the formula of $(1\text{-pij})^{-1}$, Where, i = 1, 2 and j = 1, 2 (in case of two state MS model).

interesting facts about the adjustment of bear/bull cycles in BSE-Sensex. The obvious inference coming out from the estimation result is that the market is more biased towards bull regime with very high persistence with positive returns and there is very high probability of occurrence of extreme events. Transition phases are adjusted very quickly given the market scenarios.

[Insert table 2 about here]

Similarly, table-2 shows the estimation results of MS (2)-AR (2) of NSE-Nifty index. It can be observed that AR (2) co-efficients are significant. In the regime represented by S_t =1 (bear phase), the average expected return in this regime is μ_1 = -0.19 percent per day with high volatility of σ_1^2 = 6.66, while in case of bull phase represented by state 2 (S_t =2), the average growth rate is μ_2 = 0.17 percent per day with low volatility of σ_2^2 = 1.21. Both regimes are persistent with varying average durations. The probability that the bear regime will be followed by another day of bear regime is p_{11} = 0.95, this regime will persist on average for 20 days (close to one month). However, the probability that the bull regime will be followed by another day of bull regime is p_{22} = 0.97, this episode will typically persist for 39 days (more than a month). It is interesting to observe that during bear regime the average expected return is negative with high volatility compared to bull regime. If we compare the bear/bull regime returns of both the markets, then it may be concluded that both markets show the similar trends in returns with almost similar volatility in respective regimes of markets.

However, the transition phases of Nifty returns mentioned in table 2 shows the similar trend of BSE-Sensex. In case of Nifty, the probability that the bear regime will be followed by bull regime represented as p_{12} = 0.03 and the average duration of this regime will be only one day. Conversely, the probability that the bull regime will be followed by bear regime is

represented as $p_{21} = 0.05$ with average persistence of 1 day. These results again unravel the similar insights about the very low duration of transition phases in both the markets. The reason could be the emerging nature of Indian economy wherein the market participants follow the herd trend with longer period of holdings and sell the holdings in the case of adverse economic conditions.

[Insert table 3 & 4 about here]

Further, the possible bull and bull regime dates for both stock market indices are obtained from the smoothed probabilities (see table 3 & table 4). In case of BSE-Sensex, thirty three (33) days of bear and bull regimes with varying durations have been identified (table 3). The average durations of bull and bear regimes are sixty nine (69) and thirty two (32) days respectively. The overall average duration of BSE-Sensex regimes is hundred (100) days. While in Nifty case, there are fifty (50) bull and bear regimes with different durations are shown in table 4. The average durations of bull and bear regimes are forty five (45) and twenty two (22) days respectively. However, the overall average duration of Nifty cycle is obtained as sixty six (66) days. If we compare the cycles durations between BSE-Sensex and NSE-Nifty then we can conclude that the average duration of both the regimes are higher in case of BSE-Sensex and even the overall average cycle's phase by more than 30 days (1 month). The reason could be due to high diversification and volume of trade taking place in BSE-Sensex than Nifty and also could be because of large listings of companies in BSE-Sensex compared to Nifty.

It may, however, be noted that during the study period the longest bull regime in BSE-Sensex is observed (see table 3) in cycle 23 (04-06-2004 to 10-05-2006) for 481 days (more than a year), followed by cycle 19 (29-05-2002 to 22-08-2003) for 308 days. Whereas, the longest bear regime is shown in cycle 30 (30-05-2008 to 24-07-2009) for 280 days. The longest

overall (bull and bear) cycle is observed in cycle 23 (04-06-2004 to 10-05-2006) for 535 days. Out of 535 days, 481 days are under bull regime and 54 days under bear regime.

Similarly, in case of Nifty (see table 4) during the study period the longest duration under bull regime is found in cycle 25 (29-05-2002 to 08-04-2003) for 216 days followed by varying periods between cycles 32 to 34 (07-06-2004 to 18-04-2006) for 152 days (on average). However, the longest bear period in NSE-Nifty is observed in cycle 44 (11-08-2008 to 23-07-2009) for 229 days followed by cycle 16 (22-12-1999 to 05-06-2000) for 112 days. The longest overall (bull and bear) cycle is observed in cycle 44 (11-08-2008 to 23-07-2009) for 231 days, out of which 229 days are under bear and 2 days under bull regimes, respectively.

This is, however, evident from the above analysis that both the markets move in more or less similar direction with varying durations of each positive/negative shocks which lead the market to either takes a jump or crash.

[Insert table 5 & 6 about here]

Apart from this, both market indices are forecasted (see table 5 & 6) further for the period of one month (15-11-2010 to 24-12-2010). The main reasons for forecasting the returns series is to have forward looking scenarios with given probabilities of each regime. In case of BSE-Sensex, the forecasted returns are positive except one period (15-11-2010). The positive returns are ranging between 0.06 to 0.19 percent per day with given probabilities of bull and bear regimes. The inference coming out from the one month forecasts of BSE-Sensex is that there is a tendency for the market to remain under the bull regime as evidenced by very high probabilities ranging from 0.71 to 0.88 compared to the 0.12 to 0.29 range under the bear regime.

Similarly, the forecasted returns of Nifty index are also falling in line with BSE-Sensex index. As it can be observed that the forecasted Nifty returns are positive with given probabilities of bull and bear regimes. The returns are varying between 0.0 to 0.20 percent per day with given probabilities of the market remaining under bull regime with very high probabilities ranging between 0.69 and 0.85 whereas bear regime is having very low probability ranging from 0.15 to 0.32. After analysing the forecasted returns of both markets, it may be inferred that the Indian stock market will remain under bullish regime with slight moderation and meagre market correction in late December 2010 as it could be easily observed by the given probabilities of the bear regime.

[Insert figure 1a & 1b about here]

[Insert figure 2a & 2b about here]

Another important insight coming out from this study is identifying durations of contagion in Indian stock market during the US sub-prime crisis of 2008. As it can be seen in (Graph 1a & 1b) that India started realizing the contagion of sub-prime crisis in BSE-Sensex from May 2008 (30-05-2008) to July (24-07-2009). The average duration of the effect of sub prime in case of BSE Sensex is 280 days. But in case of Nifty the smoothed probabilities (see Graph 2a, 2b) show that the sub-prime contagion started realizing from mid of August 2008 (11-08-2008) and ended in July 2009 (23-07-2009) with average duration of 229 days. But the impact of European crisis (2010) was not much visible which could be due to rising share prices, strong investor interest, and sentiment of global recovery with little market corrections; otherwise there is not very high duration of bear regime, implying that after the contagion effects of US Sub-prime Indian stock market remained bullish due to large inflow of capital in portfolio investment and heavy borrowing made by domestic corporations through IPOs and FPOs. But the uncertainties arising due to fear of double deep-recession

and slow recovery observed in USA and Euro-zone economies has further abridged the chances of strong global economic recovery. This might lead to chaos in Indian stock market with the possibility of considerable market corrections ahead.

6. Concluding remarks

India as a developing economy with a growth rate of around nine percent per annum has received considerable attention across the globe with heavy investment in all the sectors opened so far for foreign investment. The post-liberalization period has particularly brought a sea-change in financial sector with more technology driven market integration and pursuance of aggressive deregulation policies. With the advent of new technology, the investment in stock market has become a usual phenomenon with more inflow of capital moving from one corner of the world to another in the fraction of a second. This has helped in enhancing the efficiency of Indian stock market. But the risk of speculation associated with such developments has become a major concern. The present study tries to provide a basic framework to understand the dynamics of stock market behaviour and attempts to identify the movements of stock market in different regimes characterized as bull and bear. Considering the fact that prediction of the stock market trend guides the policy makers in undertaking timely intervention and is a help to speculators to play safe and avoid losses, the study estimates and forecast the MS (2)-AR (2) model for both leading indices (BSE-Sensex and NSE-Nifty) of Indian stock market using daily data for the period July-1997 to December-2010. The MS (2)-AR (2) model predicts that Indian stock market will remain under bull regime with very high probability compared to the bear regime. The persistence of the bull regime is more than one month in both the markets. The study results also highlight the bear phases during sub-prime crisis (2008) which is more than a year with an average duration of 254 days in both market indices. But there is no evidence of severe effect of European Debt

crisis (2010) in both indices of Indian stock market. The one month forecasts of both the market indices further substantiate the presence of similar trends of Indian stock market to remain under bull regime with very high probabilities and slight moderation in late decemeber-2010. Finally, the study concludes, in the backdrop of economic liberalization policies, that Indian stock market in recent years has become more sensitive to external shocks implying that there is ample scope of policy interventions. This is mainly because as the economy treads a higher growth path and is subjected to greater opening and financial integration with rest of the world, the stock markets in all its aspects need further considerable attention, along with corresponding measures to continue modernization and strengthening.

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Table 1: Maximum likelihood Estimates for MS (2) - AR (2) model of BSE-Sensex

Variable	Coefficient	Standard error	t-statistics	p-value
ϕ_1	0.090	0.018	4.9	0.0000
ϕ_2	-0.039	0.018	-2.2	0.0320
μ_1	-0.177	0.088	-2.0	0.0430
μ_2	0.155	0.027	5.7	0.0000
σ_1^2	6.791	0.074	35.0	0.0000

σ_2^2	1.214	0.026	42.2	0.0000
p_{11}	0.961	0.009	113.0	0.0000
p_{21}	0.019	0.004	4.5	0.0000
p_{22}	0.98			
p_{21}	0.04			
Linearity LR test	868.69 [0.0000]**			
Log likelihood	-6083.43			
AIC	3.6906			

Notes: The LR linearity test is distributed as a chi-square with d degrees of freedom, i.e. $\chi 2$ (d); p-values are reported in square brackets. ** denotes significance of the coefficient (rejection of the null hypothesis in the case of linearity test) at the 1% level.

Table 2: Maximum likelihood Estimates for MS (2) - AR (2) model of NSE-Nifty

Variable	Coefficient	Standard error	t-statistics	p-value
ϕ_1	0.085	0.018	4.610	0.000
ϕ_2	-0.047	0.018	-2.610	0.009
μ_1	-0.191	0.084	-2.280	0.023
μ_2	0.171	0.028	6.130	0.000
σ_1^2	6.661	0.078	33.000	0.000
σ_2^2	1.122	0.029	36.700	0.000
p_{11}	0.95	0.010	95.100	0.000
p_{21}	0.03	0.005	4.980	0.000
p_{22}	0.97	--	--	--
p_{12}	0.05	--	--	--
Linearity LR test	886.94 [0.0000]**			
Log likelihood	-6099.12			
AIC	3.68231			

Notes: The LR linearity test is distributed as a chi-square with d degrees of freedom, i.e. $\chi 2$ (d); p-values are reported in square brackets. ** denotes significance of the coefficient (rejection of the null hypothesis in the case of linearity test) at the 1% level.

Table 3: Bull and Bear regimes of each cycle in BSE-Sensex

Cycle	Bull and bear regimes for each cycle				Duration of bull and bear regimes (in days)		Cycle Duration (in days)
	Bull regime		Bear regime		Bull	Bear	
Cycle1	04-07-1997	08-08-1997	11-08-1997	01-09-1997	26	13	39

Cycle 2	02-09-1997	17-11-1997	18-11-1997	28-11-1997	51	9	60
Cycle3	01-12-1997	07-01-1998	08-01-1998	02-02-1998	27	16	43
Cycle4	03-02-1998	16-04-1998	17-04-1998	01-09-1998	47	94	141
Cycle5	02-09-1998	25-09-1998	28-09-1998	28-10-1998	18	19	37
Cycle6	29-10-1998	16-12-1998	17-12-1998	25-01-1999	34	25	59
Cycle7	27-01-1999	25-02-1999	26-02-1999	02-06-1999	22	62	84
Cycle8	03-06-1999	09-07-1999	12-07-1999	14-07-1999	27	3	30
Cycle9	15-07-1999	05-10-1999	06-10-1999	04-11-1999	58	21	79
Cycle10	05-11-1999	21-12-1999	22-12-1999	17-01-2000	30	18	48
Cycle11	18-01-2000	03-02-2000	04-02-2000	07-06-2000	13	84	97
Cycle12	08-06-2000	14-07-2000	17-07-2000	27-07-2000	26	9	35
Cycle13	28-07-2000	13-09-2000	14-09-2000	25-10-2000	30	29	59
Cycle14	27-10-2000	08-11-2000	09-11-2000	14-11-2000	9	4	13
Cycle15	15-11-2000	20-02-2001	21-02-2001	30-04-2001	67	46	113
Cycle16	02-05-2001	10-09-2001	11-09-2001	10-10-2001	92	21	113
Cycle17	11-10-2001	25-02-2002	26-02-2002	04-03-2002	91	5	96
Cycle18	05-03-2002	17-05-2002	20-05-2002	28-05-2002	51	7	58
Cycle19	29-05-2002	22-08-2003	25-08-2003	26-08-2003	308	2	310
Cycle20	27-08-2003	11-09-2003	12-09-2003	26-09-2003	12	11	23
Cycle21	29-09-2003	14-01-2004	15-01-2004	04-02-2004	74	13	87
Cycle22	05-02-2004	05-05-2004	06-05-2004	03-06-2004	61	21	82
Cycle23	04-06-2004	10-05-2006	11-05-2006	25-07-2006	481	54	535
Cycle24	26-07-2006	11-12-2006	12-12-2006	12-12-2006	95	1	96
Cycle25	13-12-2006	21-02-2007	22-02-2007	03-04-2007	46	28	74
Cycle26	04-04-2007	26-07-2007	27-07-2007	27-08-2007	79	21	100
Cycle27	28-08-2007	01-10-2007	03-10-2007	22-11-2007	25	37	62
Cycle28	23-11-2007	14-12-2007	17-12-2007	17-12-2007	16	1	17
Cycle29	18-12-2007	14-01-2008	15-01-2008	08-04-2008	17	57	74
Cycle30	09-04-2008	29-05-2008	30-05-2008	24-07-2009	33	280	313
Cycle31	27-07-2009	04-08-2009	05-08-2009	20-08-2009	7	12	19
Cycle32	21-08-2009	29-10-2009	30-10-2009	04-11-2009	45	3	48
Cycle33	05-11-2009	12-11-2010	--	--	257	--	257
Average duration of bull and bear regimes' cycle					**69**	**32**	**100**
Median duration of bull and bear regimes' cycle					**34**	**19**	**74**

Table 4: Bull and Bear regimes of each cycle in NSE-Nifty

Cycle Nifty	**Bull and bear periods for each cycle**		**Duration of bull and bear periods (in days)**		**Cycle Duration (in days)**
	Bull period	**Bear period**	**Bull**	**Bear**	

Cycle1	04-07-1997	20-08-1997	21-08-1997	29-08-1997	32	7	39
Cycle 2	01-09-1997	23-10-1997	24-10-1997	04-11-1997	34	7	41
Cycle3	05-11-1997	07-11-1997	10-11-1997	01-12-1997	3	15	18
Cycle4	02-12-1997	07-01-1998	08-01-1998	13-01-1998	26	4	30
Cycle5	14-01-1998	26-02-1998	27-02-1998	05-03-1998	30	5	35
Cycle6	06-03-1998	07-04-1998	09-04-1998	16-04-1998	22	5	27
Cycle7	17-04-1998	08-05-1998	11-05-1998	21-05-1998	14	9	23
Cycle8	22-05-1998	22-05-1998	25-05-1998	05-08-1998	1	53	54
Cycle9	06-08-1998	06-08-1998	07-08-1998	02-09-1998	1	18	19
Cycle10	03-09-1998	25-09-1998	28-09-1998	26-10-1998	17	18	35
Cycle11	27-10-1998	16-12-1998	17-12-1998	12-02-1999	38	39	77
Cycle12	15-02-1999	24-02-1999	25-02-1999	04-03-1999	8	6	14
Cycle13	05-03-1999	30-03-1999	31-03-1999	01-06-1999	18	43	61
Cycle14	02-06-1999	09-07-1999	12-07-1999	21-07-1999	28	8	36
Cycle15	22-07-1999	01-10-1999	04-10-1999	03-11-1999	51	23	74
Cycle16	04-11-1999	21-12-1999	22-12-1999	05-06-2000	33	112	145
Cycle17	06-06-2000	14-07-2000	17-07-2000	27-07-2000	29	9	38
Cycle18	28-07-2000	14-09-2000	15-09-2000	25-10-2000	33	28	61
Cycle19	26-10-2000	10-11-2000	13-11-2000	13-11-2000	12	1	13
Cycle20	14-11-2000	21-12-2000	22-12-2000	22-12-2000	28	1	29
Cycle21	26-12-2000	20-02-2001	21-02-2001	30-04-2001	40	46	86
Cycle22	02-05-2001	10-09-2001	11-09-2001	28-09-2001	92	14	106
Cycle23	01-10-2001	26-02-2002	27-02-2002	01-03-2002	101	3	104
Cycle24	04-03-2002	17-05-2002	20-05-2002	28-05-2002	52	7	59
Cycle25	29-05-2002	08-04-2003	09-04-2003	11-04-2003	216	3	219
Cycle26	15-04-2003	22-08-2003	25-08-2003	27-08-2003	91	3	94
Cycle27	28-08-2003	10-09-2003	11-09-2003	26-09-2003	10	12	22
Cycle28	29-09-2003	14-01-2004	15-01-2004	09-02-2004	77	16	93
Cycle29	10-02-2004	18-02-2004	19-02-2004	01-03-2004	7	8	15
Cycle30	03-03-2004	12-03-2004	15-03-2004	15-03-2004	8	1	9
Cycle31	16-03-2004	23-04-2004	27-04-2004	04-06-2004	28	29	57
Cycle32	07-06-2004	04-01-2005	05-01-2005	12-01-2005	149	6	155
Cycle33	13-01-2005	21-09-2005	22-09-2005	22-09-2005	174	1	175
Cycle34	23-09-2005	10-04-2006	12-04-2006	18-04-2006	134	4	138
Cycle35	19-04-2006	10-05-2006	11-05-2006	25-07-2006	16	55	71
Cycle36	26-07-2006	07-12-2006	08-12-2006	14-12-2006	94	5	99
Cycle37	15-12-2006	19-02-2007	20-02-2007	03-04-2007	42	30	72
Cycle38	04-04-2007	26-07-2007	27-07-2007	27-08-2007	79	21	100
Cycle39	28-08-2007	03-10-2007	04-10-2007	31-10-2007	26	20	46
Cycle40	01-11-2007	08-11-2007	09-11-2007	23-11-2007	6	11	17
Cycle41	26-11-2007	12-12-2007	13-12-2007	24-12-2007	13	7	20
Cycle42	26-12-2007	14-01-2008	15-01-2008	08-04-2008	14	58	72
Cycle43	09-04-2008	28-05-2008	29-05-2008	06-08-2008	32	50	82
Cycle44	07-08-2008	08-08-2008	11-08-2008	23-07-2009	2	229	231
Cycle45	24-07-2009	05-08-2009	06-08-2009	24-08-2009	9	9	18
Cycle46	25-08-2009	26-10-2009	27-10-2009	06-11-2009	40	8	48
Cycle47	09-11-2009	18-01-2010	19-01-2010	11-02-2010	48	2	50
Cycle48	15-02-2010	07-05-2010	10-05-2010	10-05-2010	56	1	57
Cycle49	11-05-2010	18-05-2010	19-05-2010	26-05-2010	6	6	12
Cycle50	27-05-2010	12-11-2010	--	--	121	--	121
Average duration of bull and bear regimes' cycle					**45**	**22**	**66**
Median duration of bull and bear regimes' cycle					**30**	**9**	**56**

Table 5. Forecasts of BSE-Sensex returns with probabilities in each regime

Forecasting BSE returns from 2010-11-15 to 2010-12-24				
Period	**Forecasts of BSE**	**Standard Error***	**Probability of bull**	**Probability of bear**

	returns		period	period
2010-11-15	-0.03	1.2745	0.88	0.12
2010-11-16	0.19	1.3174	0.87	0.13
2010-11-17	0.12	1.3223	0.86	0.14
2010-11-18	0.10	1.3298	0.85	0.15
2010-11-19	0.10	1.3645	0.84	0.16
2010-11-22	0.10	1.3603	0.83	0.17
2010-11-23	0.10	1.3682	0.82	0.18
2010-11-24	0.09	1.4006	0.81	0.19
2010-11-25	0.09	1.3974	0.80	0.20
2010-11-26	0.09	1.4028	0.80	0.20
2010-11-29	0.09	1.4346	0.79	0.21
2010-11-30	0.08	1.4554	0.78	0.22
2010-12-01	0.08	1.4257	0.78	0.22
2010-12-02	0.08	1.4378	0.77	0.23
2010-12-03	0.08	1.4748	0.77	0.23
2010-12-06	0.08	1.4576	0.76	0.24
2010-12-07	0.07	1.4722	0.76	0.24
2010-12-08	0.07	1.5200	0.75	0.25
2010-12-09	0.07	1.4988	0.75	0.25
2010-12-10	0.07	1.5110	0.74	0.26
2010-12-13	0.07	1.5127	0.74	0.26
2010-12-14	0.07	1.5217	0.74	0.26
2010-12-15	0.07	1.5108	0.73	0.27
2010-12-16	0.06	1.4944	0.73	0.27
2010-12-17	0.06	1.4889	0.73	0.27
2010-12-20	0.06	1.4885	0.72	0.28
2010-12-21	0.06	1.5066	0.72	0.28
2010-12-22	0.06	1.5179	0.72	0.28
2010-12-23	0.06	1.5255	0.72	0.28
2010-12-24	0.06	1.5488	0.71	0.29
* Standard errors based on 10,000 replications				

Table 6. Forecasts of NSE-Nifty returns with probabilities in each regime

Forecasting NSE-Nifty returns from 2010-11-15 to 2010-12-24				
Period	**Forecasts of Nifty returns**	**Standard Error***	**Probability of bull period**	**Probability of bear period**
2010-11-15	0.00	1.2858	0.85	0.15
2010-11-16	0.20	1.3321	0.83	0.17
2010-11-17	0.12	1.3405	0.82	0.18
2010-11-18	0.10	1.3505	0.81	0.19
2010-11-19	0.10	1.3877	0.80	0.20
2010-11-22	0.09	1.3849	0.79	0.21
2010-11-23	0.09	1.394	0.78	0.22
2010-11-24	0.09	1.4277	0.77	0.23
2010-11-25	0.08	1.4246	0.76	0.24
2010-11-26	0.08	1.4304	0.75	0.25
2010-11-29	0.08	1.4622	0.75	0.25
2010-11-30	0.08	1.4832	0.74	0.26
2010-12-01	0.08	1.4532	0.73	0.27
2010-12-02	0.07	1.4645	0.73	0.27
2010-12-03	0.07	1.5018	0.72	0.28
2010-12-06	0.07	1.4831	0.72	0.28
2010-12-07	0.07	1.4976	0.71	0.29
2010-12-08	0.07	1.5446	0.71	0.29
2010-12-09	0.07	1.5223	0.71	0.29
2010-12-10	0.06	1.5333	0.70	0.30

2010-12-13	0.06	1.5341	0.70	0.30
2010-12-14	0.06	1.5423	0.70	0.30
2010-12-15	0.06	1.5302	0.69	0.31
2010-12-16	0.06	1.5126	0.69	0.31
2010-12-17	0.06	1.506	0.69	0.31
2010-12-20	0.06	1.5046	0.69	0.31
2010-12-21	0.06	1.5214	0.69	0.31
2010-12-22	0.06	1.5317	0.68	0.32
2010-12-23	0.06	1.5387	0.68	0.32
2010-12-24	0.06	1.5611	0.68	0.32
* Standard errors based on 10,000 replications				

Figure 1a

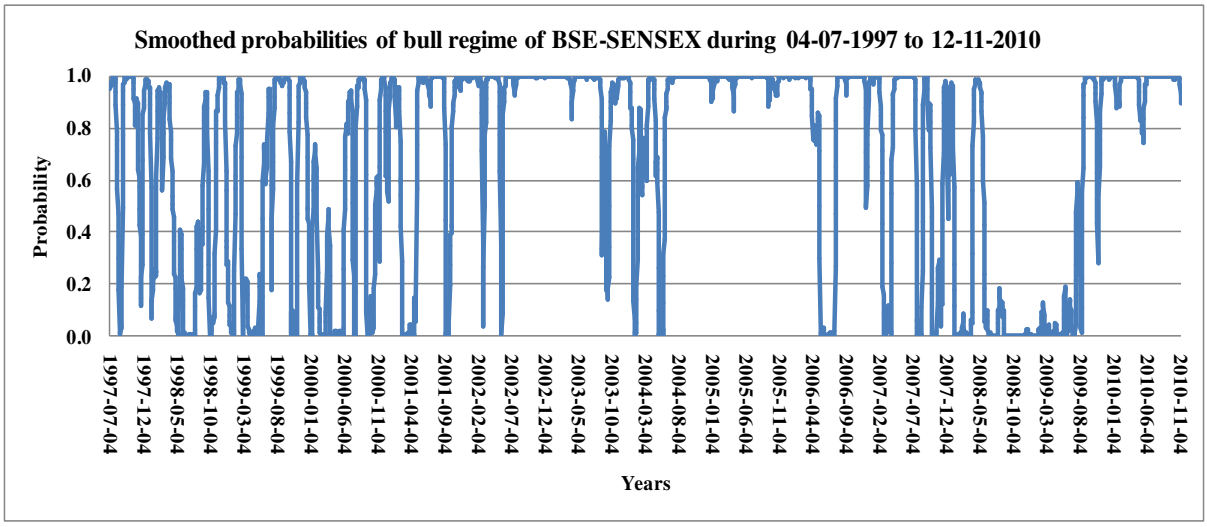


Figure 1b

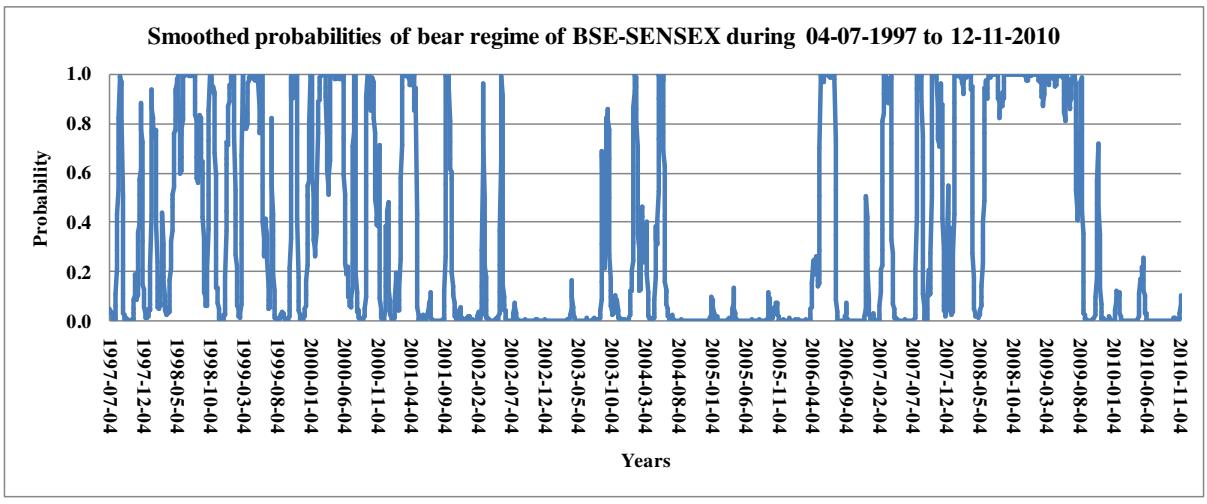
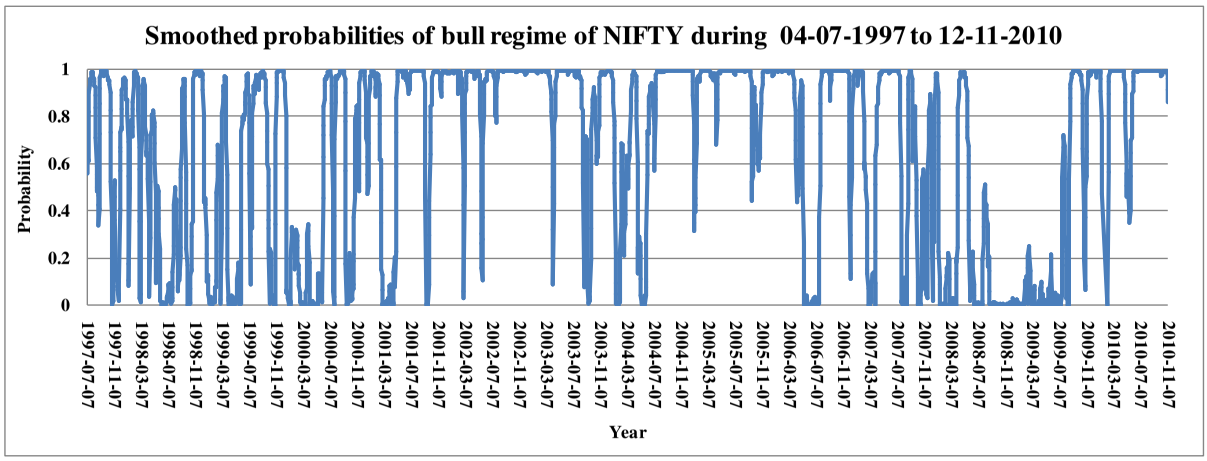


Figure 2a


Smoothed probabilities of bull regime of NIFTY during 04-07-1997 to 12-11-2010
Probability
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0.8
0.6
0.4
0.2
0
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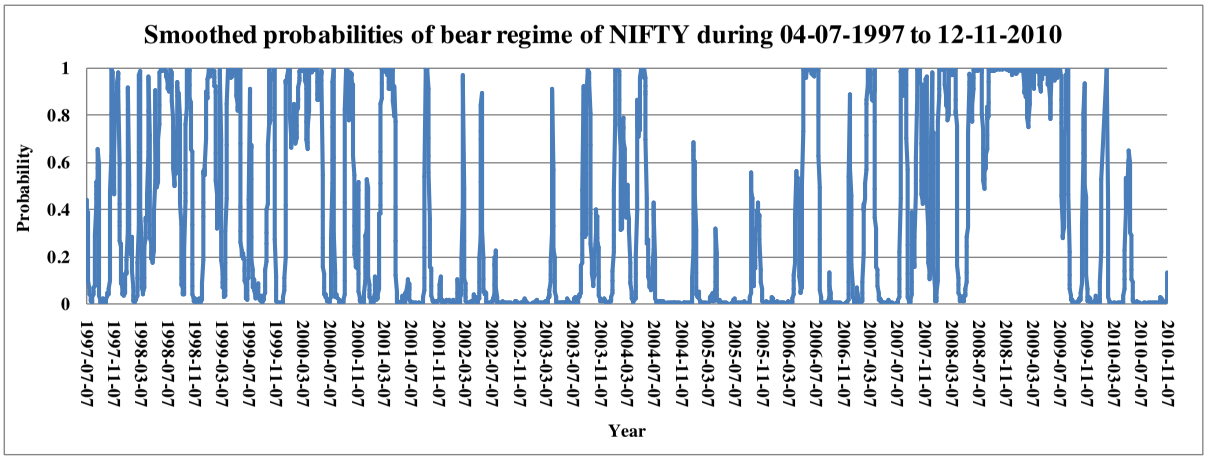
2009-11-07
2010-03-07
2010-07-07
2010-11-07
Year

Figure 2b


Smoothed probabilities of bear regime of NIFTY during 04-07-1997 to 12-11-2010
Probability
1
0.8
0.6
0.4
0.2
0
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1997-11-07
1998-03-07
1998-07-07
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