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An In-Depth Study on Bubble Detection in the Indian Stock Market

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INTRODUCTION

The stock market, being a global and interconnected entity, has a significant impact on a country's financial and business landscape.It serves as a platform for trading securities worldwide, enabling the formation of capital and facilitating firms to raise funds for their operations. By encouraging investment and fostering innovation, the stock market generates significant employment opportunities and fosters transparency among companies. Moreover, it empowers individuals to grow their wealth through investments, contributing to overall economic prosperity. Indian stock market stands as a vital indicator of the country's financial health. The Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) are the major exchanges that facilitate the trading of a number of financial instruments, including equities, derivatives, bonds, and commodities. Their robustness and diverse participation have played pivotal roles in India's economic growth, further fueled by the economic liberalization policies implemented in the 1990s. These reforms opened up the Indian economy to the world, attracting foreign inflows and driving remarkable technological advancements and foreign investments, leading to substantial economic development.

Despite the market's significance and potential benefits, it is not without its challenges. One such challenge is the emergence of market bubbles. A bubble happens when the price of a stock or the market as a whole deviate greatly from its intrinsic value, which is often driven by speculation rather than underlying asset value.Accurately detecting and understanding these bubbles are of paramount importance for investors and policymakers, as they can have far-reaching implications for financial stability and economic growth.This research paper aims to undertake an in-depth study on bubble detection in the Indian stock market. By analyzing historical data and market indicators, we seek to identify and comprehend the patterns associated with bubble formations. Through a meticulous examination of the BSE Sensex index over the past 23 years, we aim to pinpoint the characteristics and signals that precede bubble development. Such insights hold the potential to provide early warning signals for future bubbles and facilitate informed decision-making for investors and policymakers alike. The objective of the study is to analyze BSE Sensex index Bubble formation patterns for last 23 years.

LITERATURE REVIEW

(Shu & Zhu, 2020) has conducted a test on detection of Chinese stock market bubbles with LPPLS confidence indicator by considering 16 years of data of Shanghai Shenzhen CSI 300 stock market index. They detected the bubble in Chinese stock market during the year 2007 and 2015. (Çıtak, 2019) author considered 24 sectoral indices in the Turkish stock market and used the GSADF test and the study finds evidence of bubbles in some sectors, including finance, technology, and industrials.(Gilbert V. Nartea, 2013) aim of the study was to find bubble footprints in the Malaysian stock market, the study covers 25 yearsThey discovered that there is inadequate proof to support the existence of rational bubbles in Malaysia's stock market.(Lehnert, 2022) conducted a study using the PSY methodology to analyze the green stock market bubble and found that high valuations, aggressive interest from individual investors, and parabolic price action were all indicators of a bubble forming in green energy stocks.(Shu & Zhu, 2020) The author employed the LPPLS model and CMA-ES to diagnose and predict the 2015 Chinese stock market bubble, and they concluded that these bubbles were not rational and were most likely generated by irrational investor behavior. (Laurini& Chaim, 2021)conducted a study on "The Brazilian Stock Market Bubble in the 2010s," the drop was not due to a bubble forming and then bursting but rather caused by other factors such as changes in government policies and international economic conditions was the conclusion .(Salhi&Alflayyeh, 2016) investigated the impact of speculation and bubble detection in stock markets, focusing on the Tunisian and Moroccan cases. They used wavelet analysis and ARDL model to analyze 131 monthly observations and 2716 daily observations from 2004 to 2014. The authors argued that although banning speculation would be impractical, regulations can mitigate its negative effects by reducing access costs, imposing taxes on short selling, and limiting financial

innovation.(Mizuno et al., 2017) Based on price dispersion among similar listed firms, the paper presents a unique strategy for spotting stock market bubbles. Their approach makes use of data from the Japanese stock market from 1993 to 2014, as well as a Markov-switching model and an LPPL model.The authors note that their method is most effective in identifying bubbles caused by speculative money flows into a small set of stocks rather than more widespread market speculation.(Forro, 2015),'Detecting the Bubbles in Financial markets: Fundamental and dynamical Approaches' has used LPPL, Dynamical analysis and Fundamental analysis and offers a view in which bubbles and their ensuring crashes are not the result of spontaneous exogenous events such as new pieces of information, but they are rather the product of maturation processes that have distinctive features that can be captured through appropriate models. (Paper & Diskussionspapiere, 2013), The article examines the existence of bubble in UK stock market from 1975 to 2009 by using PP test, LPPL model and a regime-switching model techniques and concluded that distinguishing the nature of the sources of asset price movements and therefore, if the eventual bursting of such bubbles is likely to be establishing for the financial system and the real economy.(Mizuno, 2019),'Detecting stock market bubbles based on the Cross-sectional dispersion of Stock Prices' examined the bubble detection using the techniques Shiller CAPE ratio and the LPPL model and the author concluded that the phenomenon of market capitalization and fundamentals during bubbles could have been used to detect the dot-com bubble of 1998-2000 across several stock markets.(Saputri, 2016), has analysed the possibility of a stock market bubble in Brazil used the GSADF test, LPPL model and PP test for a duration of 16years and The findings suggest evidence of a bubble in 2003 due to strong market recovery, political stabilization, and excess liquidity in developed markets.(Rappoport & White, 1991), the article 'Was there a bubble in the 1929 stock market?' examines the existence of a bubble in the American stock market for 5 years using unit root test and cointegration test. The study finds that while the margin requirements and estimated bubbles do not support a bubble large enough to cause the crash of the stock market, the traditional accounts of a bubble in the market cannot be easily dismissed.(Demirer, 2017), the article 'On the predictability of stock market bubbles: evidence from LPPLS confidence multi-scale indicators' studies for 41 years and concludes that metrics of short selling activity have strong prediction value over negative bubbles over both short and long time horizons. Market liquidity, on the other hand, is found to have robust predictive power over both the negative and positive bubbles.(Moinas & Pouget, 2009), has examined rational and irrational bubbles in the France market in 2009 only for 1 year, using the Poisson CH model. The study finds that the decision to speculate and enter into a bubble is positively related to being first in the market sequence, and negatively related to risk aversion and being last in the market sequence, as well as the number of iterated steps of reasoning required to rule out bubbles.(Id & Greenspan, 2020), 'Fear and Stock price bubbles' explores the relationship between fear and stock price bubbles in the US return index for 55 years. The findings of the study, price run-up initially occurs in periods of euphoria, followed by a crash due to increasing fear.

Moreover, the study suggests that on average, fear begins to set in roughly a year before an industry crashes, and euphoria turns into fear, while the market is still bullish. However, the study finds no particular euphoria-fear pattern for price runs in industries that do not subsequently crash.(Africa, n.d.), the article 'Testing for Bubbles in the BRICS Stock Markets' from 1990 to 2013 for a period of 23 years finds that the strength of bubbles differs across markets and appears to be stronger for Brazil, Russia, and South Africa based on graphical evidence. The author had investigated the existence of the bubbles present in the sectorial indices of National stock exchange of India by employing a variance of the ratio test to detect and analyze 10 sectoral indices in the period 2001- 2020 and concluded that the presence of the bubbles in the sectoral indices has made the people to know the importance of diversification, while picking the stock for the investments.(Zeren &Yilanci, 2019) The study examined the bubbles in the various sectors of the national stock exchange in India, using the Generalized Supremum Augmented Dickey-Fuller (GSADF) test and concluded that you need to continuously monitor of the asset prices to detect the potential bubbles and take proper measures to prevent financial instability and provide insights to investors in managing sectoral indices.(Chang et al., 2007) has investigated the presence of the rational bubbles in the US stock market using the nonparametric cointegration test to verify the long-run relationship between stock prices and the dividends and suggested that there is evidence of rational bubbles in the us stock market.(Junttila, 2003) has examined the speculative bubbles in the IT sector in the US market during the period 1990 to 2000 using the unit root test and argues that the dynamics which are included in the IT markets are completely different from the traditional markets. (Yuhn et al., 2015) has investigated the bubble in the US stock market to identify the Bubbles in asset prices and concluded that the Bubble tool is one of the tools to locate the Bubbles in asset values. (Deev et al., 2014)has researched rational speculative bubbles in central European stock markets from 2004 to 2007 using the duration dependence test and discovered that the bubbles will occupy periods of great economic growth, causing a rise in foreign investment in that region.(Fullana& Ruiz, 2016) has investigated the connection between the stock market bubble and the monetary policy effects using the quantitative approach in the US as well as the Japan market and concluded that the monitory policy will have some effect in the stock market bubbles.(Zhang et al., 2020) has investigated the bubbles present in the Defence sector during the period 2005 to 2016 by employing the Sequential ADF tests to test the samples and has concluded that the tremendous amount of growth in the China's defence budget has generated the way to for the bubbles to generate in the stock market, which has led them to the disputes with the neighboring countries.

RESEARCH METHODOLOGY

This research paper considered 23 years BSE Sensex closing price and used ADF test, Rolling ADF test, RADF and SADF test to check the bubble formation.

Data Analysis and Interpretation

Normality Test

To check the normality of the selected Sensex data points the ADF test has been applied in this research. Considered null hypothesis is the selected data is normally distributed.

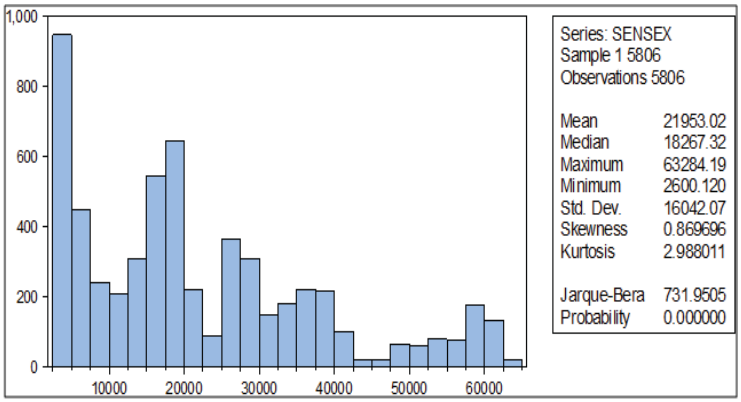

Fig. 1: Normality test of Sensex Index

Normality test resulted that, the selected index does not normally distribute since the JB test value of 731.95 with p-value is less than 0.01. Since the stock market data majority of the cases does not normally distributed. The BSE Sensex data over a 23-year period has a 0.869696 skewness.

The distribution of BSE Sensex is positively skewed.The BSE Sensex has a kurtosis value of 2.988, which indicates that the distribution is mesokurtic with moderate tails. Compared to a normal distribution, it is neither excessively peaked nor flat.

ADF Test: To check the stationarity of the selected Sensex data points the ADF test has been applied in this research. Considered null hypothesis is the selected data is non-Stationary / has a unit root problem.Table: 1.1: ADF test for Sensex index at level

Null Hypothesis: SENSEX has a unit root			
Exogenous: Constant, Linear Trend			
Lag Length: 0 (Automatic - based on SIC, maxlag=33)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.59756	0.7942
Test critical values:	1% level	-3.95962	
	5% level	-3.41058	
	10% level	-3.12706	
*MacKinnon (1996) one-sided p-values.			

ADF test at level t-statistic value 1.597 with respect to probability value 0.794 which resulted data is not stationary at level and the same cannot be considered for further prediction research.

Table: 1.2: ADF test for Sensex index at first difference

Null Hypothesis: D(SENSEX) has a unit root			
Exogenous: Constant, Linear Trend			
Lag Length: 0 (Automatic - based on SIC, maxlag=33)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-74.1844	0.0001
Test critical values:	1% level	-3.95962	
	5% level	-3.41058	
	10% level	-3.12706	
*MacKinnon (1996) one-sided p-values.			

The ADF test of first difference resulted that it has no unit root problem. Hence it is stationary at first difference and found that t-statistic value 74.1844 with respect to Probability value less than 0.01.

Auto Correlation

Auto correlation test has been calculated and found that data has auto correlation problem.

RADF Test

To detect the bubble in the selected Sensex data, The RADF test has been applied in this research. Considered null hypothesis is There is no bubble in the BSE Sensex Stock market

Table 1.3: RADF test for Sensex index

Right Tailed ADF Tests			
Sample: 1 5806			
Included observations: 5806			
Null hypothesis: SENSEX has a unit root			
Lag Length: Fixed, lag=0			
Window size: 195			
		t-Statistic	Prob.*
max RADF		2.79822	0.007
Test critical values**:	99% level	0.631126	
	95% level	-0.0621	
	90% level	-0.42853	
*Right-tailed test			
**Critical values are based on a Monte Carlo simulation (run with EViews)			

The RADF test resulted that there is a bubble in the BSE Sensex stock market and found that t-statistic value 2.7982 with respect to Probability value 0.007.

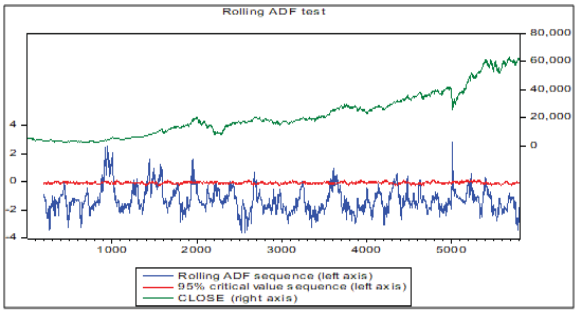

Fig.2: RADF test of Sensex index

SADF TEST

To detect the bubble in the selected Sensex data, The SADF test has been applied in this research. Considered null hypothesis is There is no bubble in the BSE Sensex Stock market

Table 1.4: SADF test for Sensex index

Right Tailed ADF Tests		
Sample: 1.5806		
Included observations: 5806		
Null hypothesis: SENSEX has a unit root		
Lag Length: Fixed, lag=0		
Window size: 195		
	t-statistic	Prob.*
SADF	1.023004	0.029
Test critical values**: 99% level	1.339265	
95% level	0.783031	
90% level	0.516901	
*Right-tailed test		
**Critical values are based on a Monte Carlo simulation(run with EViews)		

The SADF test resulted that there is a bubble in the BSE Sensex stock market and found that t-statistic value 1.0230 with respect to Probability value 0.029.

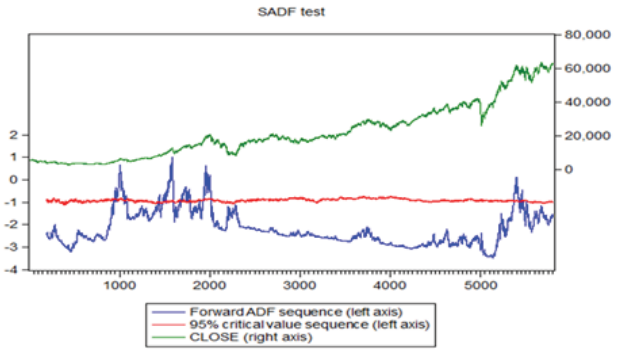

Fig.3: SADF test of Sensex index

CONCLUSION

In this study we conducted a thorough investigation into detecting a bubble in Indian stock market. Which helped in gaining deeper understanding of speculative market behaviour and their potential implications. By analysing historical data and employing advanced statistical methods, we have identified significant patterns and characteristics associated with market bubbles.

In order to identify bubble in Bombay Stock Exchange, we have taken daily closing price of SENSEX for the past 23 years, deployed statistical analysis tools such as unit root test, Augmented Dickey-Fuller (ADF) test, Right Tailed ADF(RADF), Supremum ADF(SADF) tests.

Our empirical results based on the above-mentioned tests indicate that there exist multiple bubbles in BSE. There are multiple reasons for occurrence of bubbles such as investor sentiment, excessive optimism etc. Future studies could provide investors with opportunities to create much more optimal portfolios by employing machine learning algorithms

and sentiment analysis techniques to continuously improve the accuracy of the existing model. Expanding the analysis to include other financial markets, such as commodities and cryptocurrencies could offer broader perspective on speculative behaviour across different asset classes.

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Annexure

Date: 07/19/23 Time: 13:25
Sample: 1 5806
Included observations: 5806

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.999	0.999	5799.5	0.000
		2	0.998	-0.009	11590.	0.000
		3	0.998	-0.007	17372.	0.000
		4	0.997	0.010	23146.	0.000
		5	0.996	-0.004	28911.	0.000
		6	0.995	-0.006	34667.	0.000
		7	0.994	0.013	40415.	0.000
		8	0.993	-0.008	46154.	0.000
		9	0.993	-0.009	51884.	0.000
		10	0.992	0.000	57606.	0.000
		11	0.991	0.001	63319.	0.000
		12	0.990	0.018	69024.	0.000
		13	0.989	-0.005	74720.	0.000
		14	0.988	-0.002	80408.	0.000
		15	0.988	-0.001	86087.	0.000
		16	0.987	-0.001	91758.	0.000
		17	0.986	0.008	97420.	0.000
		18	0.985	-0.011	103074	0.000
		19	0.984	-0.005	108720	0.000
		20	0.983	-0.006	114357	0.000
		21	0.983	0.002	119985	0.000
		22	0.982	0.002	125604	0.000
		23	0.981	0.000	131215	0.000
		24	0.980	0.008	136818	0.000
		25	0.979	0.001	142412	0.000
		26	0.978	0.003	147998	0.000
		27	0.978	-0.011	153575	0.000
		28	0.977	0.011	159144	0.000
		29	0.976	-0.004	164705	0.000
		30	0.975	0.005	170258	0.000
		31	0.974	0.011	175803	0.000
		32	0.974	0.007	181339	0.000
		33	0.973	0.005	186868	0.000
		34	0.972	0.009	192390	0.000
		35	0.971	0.000	197904	0.000