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A STUDY ON RATIONAL PRICE BUBBLE IN S&P BSE SENSEX

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Abstract

Stock market bubbles which have the capability of driving an entire stock market index from the real world of valuation find their rot in herd behavior and is often dangerous as public money gets stuck in such financial hurricane more often than not. This study is conducted to predict such stock market bubble on S&P BSE SENSEX on the onset of 2008 global crisis keeping the crisis in the middle of the sixteen-year period, thus breaking the period into halves. This study extends Ghosh's (2016) study done on CNX NIFTY. Similar methodology has been applied to test possibility of Rational Bubble in S&P BSE Sensex. Three variants of the Right-tailed Augmented Dickey Fuller tests (ADF, SADF, and RADF) are used to arrive at the conclusion.

Keywords: *Bubble, ADF, RADF, SADF, Sensex*
JEL Classification: *C5, C15, C22*

I. INTRODUCTION

The term 'bubble' has extensively been used in financial glossary to refer to asset prices that exceeds an asset's fundamental valuation. This happens because current owners tend to believe that they can resell that asset at even higher prices. The time period in consideration is very short and also collapses in matter of almost equal or even lesser period of time. In financial terminologies, these are the 'destabilizers' that result due to 'Herding behavior' in the market which explains the causes of explosive behavior in asset prices. The reason behind calling these bubbles as destabilizers rests in the fact that they put a structural break in the time series. Moreover, the opportunity cost of the investors also goes up as the time is lost. The frequent entry of big FII and DII can cause such shocks. But the matter of concern is that such repetitive shocks result in avalanche breakdown in the stock markets or commodity markets. Often 'behavioral finance' gives the most apt answers to the cause of bubbles in bourses. One of the most common reasons that can be cited is that a group of people often follow a financial guru rather than taking decisions post calculations.

II. LITERATURE REVIEW

Many researchers in the past have spotted bubble in stock markets and have even reported such stochastic time-series with a drift. In 1965 and 1936, two important researches were done. The importance of the first one rests in the fact that Fama confirmed with efficient market hypothesis that bubbles cannot exist in stock market time series. But this was proven wrong and is a well-known fact over these past five decades. Back in 1936, Keynes actually explained why there is always a possibility of bubbles in stock markets. Bubbles can explain volatility in stock markets. Yangru Wu in his research paper in 1997 actually dealt with the fact if rational stochastic asset bubbles explain the excess volatility in stock prices. The bubble talked about in his paper is an unobserved state vector in the state-space model and can easily be estimated using the Kalman filter. Shiller in 1979 actually constructed and administered the first bubble test "Variance Bound Test" that used the calculation of the present value of dividends paid to predict the rational value of a stock. Kenneth West wrote three important papers during 1987 and 1988. In one of them, he suggested some non-standard models like 'fads' models that can be used for measuring expected returns. In the second one, he suggested that a standard efficient market model is one in which a stock price and the expected present discounted value of its dividend are equal, with a constant discount rate. In his third paper, he mentioned the test for speculative bubbles which can be used as parameters to calculate the expected present discounted value of a stream of dividends. Stephen LeRoy and Richard Porter in 1981 suggested the use of test based models on implied variance bounds for such cases. Barlevy in 2007 reviewed what the economic theory tells when bubbles can occur and he also reviewed some examples of economic models in which there are the chances of bubble occurrence and the policy implications that have been derived therefrom. Caspi in 2013 derived that when the null hypothesis is rejected, there is a high chance of occurrence of bubble and SADF and GSADF tests finally gave the perfect conclusion of its occurrence. Diba and Grossman in 1988b concluded that positive rational bubble can only occur at the first day of trading of stock and a bubble that has already busted cannot restart. If still the bubble exists then it may be the case that the stock has been overvalued with respect to the market fundamentals since the first day of trading. Evans in 1991 proved that no one can determine the characteristics of rational bubble using unit root tests and simulations. Flavin in 1983 suggested that the "Volatility" and the "Variance test" tend to be biased for small samples that lead to the rejection of null hypothesis for efficiency of market. Flood and Garber in 1980 came out with the conclusion that no bubbles were present during German Hyperinflation. Gürkaynak in 2005 told that the Econometric detection of asset price bubble can never be achieved perfectly, some flaws always tend to remain. Jarrow, Protter & Shimbo in 2007 came out with a new theory of "Bubble birth". Jiang, Zhou, Sornette, Woodard, Bastiaensen & Caudwell's in 2010 used LPPL model to analyze the two types of bubbles and the market crashes were exhibited for Shanghai Stock Market Composite Index and Shenzhen Stock Market Composite Index during May 2005 to July 2009. Ghosh in 2016 used the four variants of the Right-tailed ADF tests to detect the presence of Asset Price Bubble in CNX Nifty and concluded its absence thereto.

III. RESEARCH METHODOLOGY

The following equation is used in the study-

$$y_t = \mu + \delta\ y(t\text{-}1) + \sum_{i=1}^{p} \varphi i\ \Delta y(t\text{-}i) + \varepsilon(t)$$

Y(t) is the daily closing price of S&P BSE SENSEX and the original time series in consideration that is being predicted by the lag 1; μ is the intercept; p is the maximum number of lags, φ is the differentiated coefficient of lag for 'i' lags and 'ε' is the error term. This entire research work has been conducted over the dataset of S&P BSE SENSEX dataset for around 16 years starting from 2000, 3rd April up to 2016, 30th June. This work includes the constituents of window size of 154 and replication of 1000. Total numbers of observations are 4023. Three tests of Right-tailed Augmented Dickey Fuller (RTADF) were performed which included ADF, RADF and SADF. RADF means Rolling ADF test. It is a type of rolling regression test that is performed on the subsequent sub-sample of the main sample with rolling forward initialization. These sub-samples are finite and fixed within a window size of 154. SADF finds the solution to a combination of various smaller problems, all such smaller problems which together constitute a bigger problem. Hence, SADF is repetitive or recursive in nature. This repetition happens by the rolling of the sub-samples. SADF or Supremum ADF has the factor 'supremum' which means 'in singular form'. It represents the least upper bound in a partially ordered set.

IV. FORMATION OF HYPOTHESIS

H_0 : δ=1
H_1 : δ<1 or δ>1

H_0 represents the null hypothesis which confirms that the linear stochastic time series data has a unit root and is non-stationary, hence there is no trace of bubble. H_1 on the other hand represents the alternate hypothesis which indicates the stationarity of the time series data indicating chances of bubble formation. It is said to have mildly explosive autoregressive coefficients which indicate traces of bubble formation. At 95% level of significance, if the p-value is less than 5%, null hypothesis is rejected which means that alternate hypothesis is accepted and there is a possibility of bubble formation. If the p-value is more than 5%, null hypothesis is accepted, i.e., there is no trace of bubble.

V. STUDY OUTPUT

Table I: Normality Test (Jarque-Bera Test)
Sample: 03/04/2000 to 30/06/2016

	CLOSEL
Mean	**9.286190**
Median	**9.581057**
Maximum	**10.29829**
Minimum	**7.863313**

Standard Deviation	0.727371
Skewness	-0.488449
Kurtosis	1.782179
Jarque-Bera	408.5724
Probability	0.000000
Sum	37358.34
Sum Squared Deviation	2127.912
Observations	4023

Table II. Regression Test

Dependent Variable: CLOSEL
Method: Least Squares
Sample (adjusted): 04/04/2000 to 30/06/2016
Included Observations: 4022 after adjustments

Variables	Coefficient	Standard Error	t- Statistic	Probability
C	8.077520	0.006142	1315.107	0.0000
CLOSE(-1)	8.95E-05	3.94E-07	227.4773	0.0000

R-Squared	0.927913	Mean Dependent Var.	9.286378
Adjusted R-Squared	0.927895	S.D. Dependent Var.	0.727363
S.E. of Regression	0.195314	Akaike info criterion	-0.427918
Sum squared residual	153.3534	Schwarz criterion	-0.424785
Log likelihood	862.5431	Hannan-Quinn criter.	-0.426808
F-Statistic	51745.92	Durbin-Watson stat.	0.013533
Probability (F-statistic)	0.000000		

Table III. Right Tailed ADF Test

Sample observations from 03/04/2000 to 30/06/2016
Included observations: 4023
Window Size: 154
H_0: δ=1; Sensex has Unit Root
Lag Length: Fixed, Lag=0

		t-Statistic	Probability
ADF		-2.100787	0.4840
Test critical values:	99% level	-0.116933	
	95% level	-0.837196	
	90% level	-1.207826	

		t-Statistic	Probability
Max. RADF		1.500533	0.0170
Test critical values:	99% level	-0.291707	
	95% level	-0.918021	
	90% level	-1.227755	

		t-Statistic	Probability
SADF		0.156524	0.2260

Test critical values:	99% level	1.085888	
	95% level	0.627781	
	90% level	0.444741	

Figure I: Graphs of Rolling ADF test

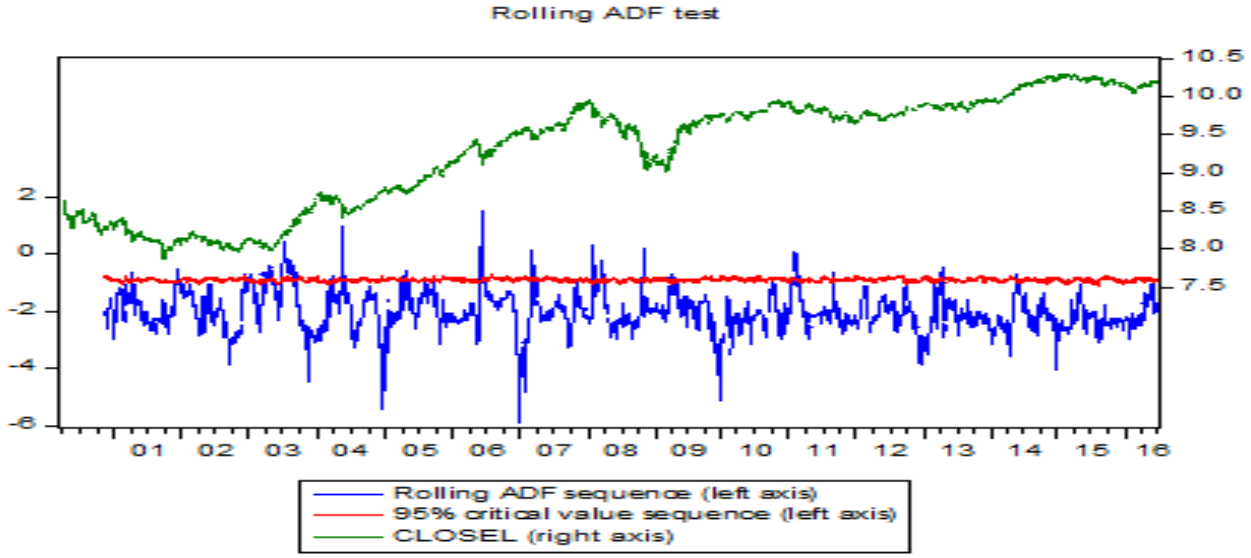
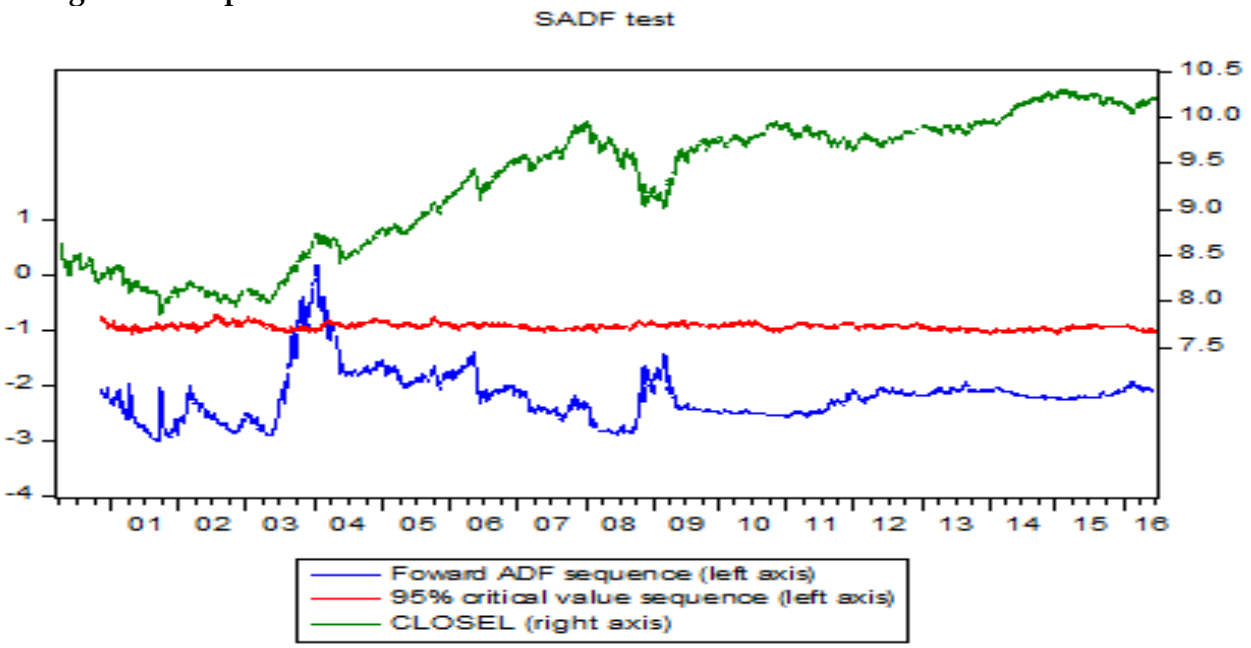


Figure II: Graph of SADF test



VI. CONCLUSION

Jarque-Bera Test - The given dataset passes the normality test. This can be understood from the Jarque-Bera test. The value obtained is 408.57, which indicates that the data is moderately normal, though not even. If the data has to qualify for being even, it should at minimum cross the barrier of 1000.

Regression Test – Here, lag 1 is used to predict the original time series. The probability of lag 1 is 0.0000, which means that the level of occurrence is 1-0 i.e., 100%. The Akaike, Schwarz and the Hannan-Quinn criterions suggest that the dataset has moderate volatility. The Darwin-Watson or DW stat is 0.0135 which is almost equal to zero. From the equation $DW = 2(1-\lambda_1)$, the value of λ_1 can be deduced and it is almost equal to 1, which means the positive auto-correlation is almost close to 1.

ADF Test – The p-value obtained after the ADF test is 48.40%, which is very high, indicating that the null hypothesis is on the onset of getting accepted. There is unit root and the dataset is non-stationary.

RADF Test – The probability obtained after the RADF test is just 1.70% which is quite low. Thus the null hypothesis is on the verge of getting rejected. It also means that the test is heading towards accepting alternate hypothesis. The dataset is stationary.

SADF Test – The p-value obtained from SADF test is 22.6%, which is also quite high, indicating that the null hypothesis is on onset of getting accepted and that there is unit root and the dataset is non-stationary.

Thus, from the three Right-tailed ADF tests, it can be seen that two tests (ADF and SADF) indicate the acceptance of null-hypothesis and suggest that there is no trace of bubble formation. While the RADF test, which is more accurate than their two other counterparts, indicates the rejection of null hypothesis and thus suggests that there is a minor chance of asset-price bubble formation in S&P BSE SENSEX.

Hence, it can be concluded that there is minor chance of bubble formation in the Indian flagship bourse SENSEX.

VII. LIMITATIONS OF THE STUDY AND SCOPE OF FUTURE WORK

Out of so many methods of spotting bubble, the three tests of Right-tailed Augmented Dickey Fuller have been performed in Indian context. Other innovative tests like artificial neural network or fuzzy network or the Generalized Supremum ADF (GSADF) test could be performed. Time span taken into consideration is over fifteen years, keeping the 2008-crash just in middle of the time span. The cardinal method of bubble detecting using dividend method was not taken into consideration as there has been a propensity to hold back surplus and issue irregular dividends by many large companies. Moreover, for detecting collapsed bubbles, Random Forest Algorithm could also be used.

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