OPEN ACCESS
Saudi Journal of Economics and Finance
Abbreviated Key Title: Saudi J Econ Fin
ISSN 2523-9414 (Print)|ISSN 2523-6563(Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage:http://saudijournals.com

Original Research Article

Testing for Multiple Bubbles in the Nigerian Stock Exchange

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DOI:10.36348/sjef.2023.v07i03.006 | **Received:** 11.02.2023 | **Accepted:** 16.03.2023 | **Published:** 24.03.2023

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Abstract

Monthly All Share Index data from 1985M01-2021M12 was sourced from the Central Bank of Nigeria and the Central Securities Clearing System of the Nigerian Stock Exchange; to analyze multiple bubble periods. The supremum Augmented Dickey Fuller (SADF) and Generalized supremum Augmented Dickey Fuller (GSADF) quantitative model with 1000 repetitions along with a window size of 42 was selected to carry out the Monte Carlo simulation at the 95% confidence level. From the Backward SADF estimation, three periods of explosive pricing and collapses were detected. The study therefore recommends that market regulators should promote market information and support regular training of market participants to stem speculations and reduce arbitrage. Overall, well-informed risk management practices should be established to guard against market losses.

Keywords: Market Bubbles, SADF, GSADF, BSADF, NSE, Monthly Series.

1. INTRODUCTION

Stock market investments areinvaluable drivers of economic growth and prosperity; and assist investors to better understand the relationship between risk and return in the long and short term. Most times, these investments are affected by both internal and external influences which may exhibit either lower or higher volatile returns due to the intense nature of investors' speculations, and thereafter lead to bubble periods.Olulu-Briggs and Odi [1] found that volatility clustering exist in stock returns, and that current level of volatility in the NSE tends to be positively correlated with its level during the immediately preceding periods which may likely lead to a bubble. Thus, an understanding of the existence of changing stock pricesand how it affects earnings is keyfor better investment decisions mainly on asset allocation and portfolio construction.

Almudhaf [2] defined asset bubbles as an observable upsurge in financial assets prices in a consistent manner; where the initial rise in price causes expectations of additional growth and hence appealing to recent buyers. Igbinovia and Igbinovia [3] assert that a bubble is caused by upsurge in share prices not supported by verifiable financial and economic fundamentals; which brings about inefficiencies in the market [4], and subsequent protract recession along with sizable economic losses [5, 6]. Bubbles occur when investors are deeply convinced that assets will experience an incessant and enhanced demand or attraction of dividend and capital gain in the foreseeable future [7]. Kujal and Powell [8] are of the view that bubbles exist and generate huge economic cost for even longer periods. To them, it is the mispricing of a firms' assets far away from their fundamental values.

Market bubbles subsist when noisy or irrational investors' exhibit the eagerness to continuously trade on stocks associated with some new technology, new markets or a potential political transformation; leading to a dramatic increase in prices which are far above their intrinsic values [9, 10]. Another related study by Abreu and Brunnermeier [9] strongly supports that bubbles occur and persist for significant periods due to individual market timing effort and the lack of coordination in stock selling strategies. The increase in price progresses gradually owing to the absence of rational arbitrageurs to correct the price anomaly by way of short selling and margin buying[11, 12]. Ackert *et al*., [11] convey that when investors sell short, and have borrowing restrictions, prices are lowered which helps to wipe out bubbles.

Theoretically, share price volatility and trading volume are the principal measures of market bubbles because they move together[13]. Other non-

fundamental elements like investment style, calendar effect, market manipulation, inside information, and investors' over confidence, noise, and deviations in political environs also activates crashes and bubbles[14]. The presence of bubbles is a negation to the efficient market hypothesis that stock prices ought to reflect all relevant information available in the market place. Researchers have recorded market bubbles and crashes like the Dutch Tulip megalomania in 1964; the Mississippi bubble in 1716; the British railway in 1840; the Wall street in 1929; the Worldwide crash in 1987 which started from Hong Kong to Asia to Europe and then the US 'Black Monday' that saw a 22% freefall of the Dow Jones Industrial Average; the Dot-com bubble in early 1990 and that of Real estate bubble in 2000 [15]. Gwarzo [16] points out that from period 2003-2007, Nigerian market capitalization grew unprecedentedly by over 66% annum, and the ASI by 380.3% from 2003-2008 yearly [17]. Also, Kighir [18] reports that between March 2008 to April 2009, ASI loss approximately 67.67%; and market capitalization fell by approximately 70% [16]. This was as a result of the sub-prime mortgage which led to a transmission of contagions effect to the Nigerian exchange.

Current and previous literature on asset bubbles and crashes have generated a lot of diverse and conflicting views on its existence [19, 2, 7, 20]. Abreu and Brunnermeier [9] put forward convincing evidence of persisting bubbles due to the overcrowding behaviour of rational arbitrageurs and speculators in the Japanese stock market. Porter and Smith [21] also found strong proof of price bubbles which is due to behavioural uncertainties of investors. Gurkaynak [22] opine that bubbles do not really exist. As such, a model that allows for risk aversion, time-varying interest rates and or structural breaks leaves less room for the existence of bubbles. Nevertheless, Phillip and Yu [23] express that in most dynamic systems, a time-varying interest rate helps to induce asset overpricing.Bosch-Rosa*et al.,* [24] reveal that bubbles exist only among investors with complex low-level reasoning. Accordingly, the existence of a bubble in experimental markets is because these investors' are confused [25]. Powell and Shestakova [26] argued that market characteristics such as investors' level of experience and market duration leads to an asset's absolute mispricing and hence bubbles. This is also the view of King *et al,* [27]; Dufwenberg*et al.,* [28]; Noussair and Powell [29]; Oechssler*et al.,* [30] that bubbles are eliminated in markets where highly- experienced investors exist. Ackert*et al.,* [11] maintained that when a firm is highly liquid, there is the possibility of a bubble. This means that its liquidity is overvalued or mispriced in relation to the values of its assets. Smith *et al.,* [31] held that more bubbles are associated with stocks that pay dividends than with those that do not. In line, Caginalp*et al.,* [32] debate that the frequent payment of dividend makes investors to trade more myopically in the short term than in the long term, thus, the higher the dividends and liquidity positions of the firm, the more bubbles is experienced [33].

Bubbles leads to crashes and momentous losses which impacts negatively on investment returns [34, 35]. The large fluctuations in market prices due to events in the economy supports more investigations on price efficiency in order to help curtail significant losses triggered by these bubbles [8, 26]. In addition, the critique by several scholar on theSmith *et al.,* [36] design demands further investigations into bubbles in multi-period asset market [37]. Hence, this study to critically investigate the existence of multiple bubbles in the Nigerian stock market using quantitative procedures. These quantitative processes assist market regulators and other participants to effectively survey market behaviors' such as upsurges in inflation and interest ratesusing the early-warning signs exhibited by the statistics [38, 23]. Most of the literature have criticized the techniques adopted for unearthing over pricing or absolute mispricing, such as the Relative Deviation technique, Relative Absolute Deviation, Average Bias, Total Dispersion, Cointegration,and the supremum Augmented Dickey-Fuller test[12, 39, 23, 35, 40, 14];while some have questionedthe type of data employed or sampling period covered. In this study, we embraced the Phillips, Wu and Yu [35] Generalized supremum Augmented Dickey-Fuller methodologyto examine the existence of bubbles in the Nigerian stock market from the inception of the market in 1985M01-2021:M12. This model identifies periods of exuberances and termination / collapse of multiple bubbles over a long historical period. It is considered the most effective real-time procedure in discovering asset bubbles because it provides for drift and autoregressive coefficients and has a high discriminatory power,as well asfunctions as a timely warning technique for crisis [41, 42]. In this study, we intend to capture bubbles within the 2007-2008 financial crisis and its rebound; seeming bubble in 2017 [42] and during Covid-19 and its variants impact on global economic meltdownin Nigeria.The study is significant for investors, financial and regulatory authorities and monetary agencies of government for proper surveillance of financial markets, risk management measures and in maintaining financial and economic stability.

This paper is divided into five section: introduction, literature review, methodology, results & discussion, conclusion & recommendations.

2. LITERATURE REVIEW

The Efficient Market Hypothesis (EMH) by Fama [43] serves as the foundation for many asset pricing models. It asserts that in an efficient market, an asset's market price reflects the best estimate of its worth at a determined period [44] likewise the current price of an asset reflects both current and predetermined information, and its fundamentals. Because prices

already exhibit all relevant information, it is impracticable for an investor to consistently outperform the market on arbitrage or risk-adjusted position. So, stock prices take a random walk and are erratic; as a result, only unexpected recent information can alter the valuations of underlying assets in stock markets (Shiller, 2015). This is due to the existence of rational and homogeneous group of investors in an efficient market having equal access to all accessible information. For the reason that bubbles are deviations from equilibrium and thus cannot occur, asset prices must exhibit their fundamentals and cannot digress from the equilibrium [43, 45, 46].

The rational bubble is a theory of asset price inflation developed by Blanchard and Watson [47], and Diba and Grossman [48], which does not contradict the rational expectations hypothesis (REH) and is reliable with the Efficient Market Hypothesis [49]. Based on the rational bubble theory, stock prices can deviate from their fundamental worth without presuming irrational investors [45]; as such there is no change in the fundamental values of the stock [50]. To complement Diba and Grossman's [48] Inception Hypothesis, market participants are aware that the asset is overvalued but are eager to pay a premium in anticipation of a future price upsurge, resulting in a rational bubble.

Diba and Grossman's [48] theoretical work on the rational bubble generated a slew of other asset bubble theories. Non-proponents of the efficient market hypothesis, for example, contended that markets and agents (or investors) are not always efficient and rational, as posited by behavioural finance theory. Accordingly, asset prices may deviate from their fundamental values, leading to either overvaluation or the formation of asset price bubbles. Price increases in assets that aren't based on solid fundamentals, are a sign of psychological contagion. In other words, a bubble is a social-psychological phenomenon [51]. In an inefficient market with information asymmetry and low transparency, some participants resort to herding styles by discarding their own signals and mimicking the trading strategies of other investors.

In the direction of Zhoua and Sornette [52], herding styles or mimicry in the marketplace results in positive feedback. This occurs when a price increase is followed by an increase in sales. Simply put, when you do something, you will receive something in return, and so on (refuting the demand law). Zhoua and Sornette [52] noted that investors' expectations for higher prices are higher, and boosts stock prices. Market bubbles are more likely to form when prices rise above their basic justification, increasing the likelihood of bubble formation.

From empirical literature, some of the investigation done by previous scholars' concerning the existence and impact of bubbles in both developed and developing stock markets are presented: Kaizoji [53] explored on speculative bubbles and crashes in the Japanese stock market using an Interacting-Agent model. The variables for the study includes the long-term interest rate (as a proxy for a firm's fundamental value) and the ratio of ordinary profits to total capital (as a proxy for investment). Applying monthly prices on Gradient-descent algorithm, the study found that bubbles and crashes are as a result of the collective crowd behavior of several interacting agents. Abreu and Brunnermeier [9] investigated bubbles and crashes in the presence of rational arbitrage. They argue that rational arbitrageurs allow bubbles to persist even when they can jointly correct it. Consequently, this is a negation to the efficient market hypothesis that rational investors make prices to be efficient. Porter and Smith [21] examined stock market bubbles in the laboratory. Reviewing the outcome of 72 articles on laboratory asset experiment, they conclude that uncertainties in market behaviours' leads to bubbles in asset markets; but this tends to diminish when well-informed traders enter the market, and then, prices reflect their fundamental values. However, with limit price change rules, the bubble increase. Gurkaynak [22] employed the standard model to test asset price bubbles in the S&P 500 index from year 1871-2003. Using the variance bounds test, west's two-step test, integration/co-integration based test, and the intrinsic bubble test; the study concludes that all these models do not sufficiently explain whether bubbles exist or not. Njiforti and Chidiogo [39] studied speculative bubbles in the Nigerian stock exchange and revealed the occurrence of bubbles, persistent volatility, and asymmetric influence. In a sample of 589 quoted firms in the New York Stock Exchange, Narayan *et al.,* [4] investigated the existence of bubble elements in asset price. Employing the SADF model, they concluded that share price instability and trading volume substantially affect stock bubbles. However at a sectorial analysis, the result was inconclusive. KorkosIoannis [54] in his submission on detecting bubbles in US asset prices employed a date-stamping technique on historical prices of the Federal Reserve Overnight Repurchase Agreement Index, Cyclical-Adjusted Price-Earnings ratio and Price-Dividend ratio to detect explosive behavior in the US stock market. From the analysis, the study concludes that though bubbles exist, the accurate dates on which it started could not be detected. Bosh-Rosa *et al.*,[24] looked into cognitive bubbles using asset market experiments. Market traders were divided into two groups of Low-level (inexperienced) and High level (experienced) traders with three measures applied in each group namely: Relative absolute deviation, Relative deviation and Positive deviation. Their findings indicate that in the low-level group, bubbles and crashes exist while the same is not recorded in the high-level group. They conclude that these bubbles and crashes are as a result of the 'Confused' state of the low-level traders. Gonçalves*et al.,* [55] employed the Log-Periodic Power Law on fundamental value

(rational) investors and trend / noisy (irrational) investors for the 1998, 2007, and 2015 Portuguese crisis period. From the estimation, the study proved stable data points for prediction of bubbles. Aigbovo*et al.,* [7] utilised some selected quoted stocks to investigate market bubbles in Nigeria from 2008Q1-2009Q4. Applying the Augmented Dickey Fuller, Generalized AutoRegressive Conditional Heteroskedasticity and co-integration methods, the result revealed the existence of bubbles. In Brazil, Costa *et al.,* [56] explored bubbles speculation on 27 Brazillian stocks and found that 20 of the 27 stocks exhibit intrinsic bubbles. Phillips and Shi [41] adopted the Phillips *et al.,* [35] approach alongside a bootstrap process on the S&P 500 index returns to detect periods of bubbles and crashes in the US as well as ballooning credit risk among European sovereign debt market. Using the logged value of price-dividend ratio on 47 US firms from January 1973-July 2018, they identified two bubbles occurrences which are the Black Monday crash on October 1987 and the Dot-com bubble from January 1996 to October, 2000. In addition, analyzing a 10-year government bond yield from June 1997-June 2016, they found one crash occurrence which is the sub-prime mortgage crisis from October 2008-February 2009. Igbinovia and Igbinovia [3] examine bubble speculation of 10 quoted banks in Nigeria from 2008Q1-2009Q1. They employed three fundamentals of share price, earnings per share and dividend yield alongside the Augmented Dickey Fuller, Augmented Engel-Granger co-integration (AEG), ARCH and GARCH tests. Their study upholds the position of bubble speculation with persistent volatility and asymmetric influence. Iliyasu and Saba [57] utilized monthly series of the All Share Index on SADF technique from 2010:M1-2017:M12. They revealed that even though prices were explosive in November, 2011, bubbles do not exist in the period under study. They attribute the occurrence to short term deviational trends. Szulczyk*etal.,* [58] examined Asian stock market bubbles using monthly and weekly series. Applying the co-integration and ADF test, they reveal that bubbles exist in all the markets they sampled.Zhang*et al.,* [59] analyzed the presence of bubbles among the agricultural commodity market in China. The study employed the generalized supreme ADF-test and affirmed the presence of bubbles.

3. METHODOLOGY

In order to avoid biased signals due to exponential rise in market prices [60, 61], the All Share Index was utilized to proxy for monthly market prices from 1985M01-2021M12.The long sample size helps to effectively identify multiple bubbles due to the variabilities in financial markets. Data was sourced from the Central Securities and Clearing System of the Nigerian Stock Exchange and the Central Bank of Nigeria database. To detect the existence of bubbles, we apply the Philips *et al.*,[23, 35]SADF and GSADF testto detect multiple bubbles includingperiods of collapse and irrational bubblesas well asthe starting date and ending points of a bubble in real time. The critical values for the SADF and GSADF test were gotten from the Monte Carlo simulation with 1000 repetitions ; using a sample size of 444 and smallest window of 42.This test is more effectivewhen compared with other tests like stationarity, west's, co-integration, variance bound, and regime-switching tests [62, 63].The Right Tailed Augmented Dickey-Fuller[64] is evaluated to detect the financial crisis of 2007/2008, CBN-MPC assertion of seeming bubbles [57], and the emergence of Covid-19 and other variants globally and its rebound. The Right Tailed Augmented Dickey-Fuller serves as a kind of forward recursive regression that helps in detecting asset price behaviour that are explosive. The equation specification is:

$$\Delta ASI_t = \beta + \delta ASI_{t-1} + \sum_{j=1}^{k} ASI_j \, \Delta ASI_{t-j} + \mu_t \ldots\ldots\ldots 1$$

Where ASI = All Share Index, β = Intercept, k = maximum number of lag, ASI_j= for j = 1… k are the differenced coefficient lags, and μ_t = stochastic term. The null hypothesis is similar with a stationary test given that the GSADF is based on the RTADF test; indicating the existence of unit root. The alternate is of mildly volatile autoregressive coefficient against the standard ADF, indicating the absence of unit root. Thus, it is stated as:

H0: $\delta = 1$

HA: $\delta > 0$

The above model in (1) employs the SADF statistic to detect multiple bubbles. The Sup ADF is a recursive procedure with window size r_w, where r_w moves from the smallest sample window which is r0 to the largest sample window which is r1, and then to the end point of the sample which is $r_2 = r_w$, thus, moving from 0 to 1. Thus:

$$SADF(r_0)\ n = \sup_{r2\in[r0,1]} ADF^{r2}_0 \ldots\ldots\ldots\ldots\ldots 2$$

In order to achieve a more extensive analysis, the GSADF is utilized which allows for a more flexible window width inside the feasible range where $r_w = r_2 - r_1$. Thus, the

$$GSADF(r_0) = \sup_{r_2\in[r_0,1]} \{ADF^{r2}_{r1}\} \ldots\ldots\ldots\ldots 3$$
$$r_1\in[0, r_2-r_0]$$

The null hypothesis of the GSADF states that share prices follow a random walk with no drift, while the alternate opine the existence of multiple bubbles.

In line with the objectives of the study, date and timing of the bubbles is required to check when the bubble actually starts and collapses. This is to assist investors and regulators on proper risk management strategies to adopt to avoid excessive losses. The date stamping equation is:

$$\hat{r}_e = \inf_{r2\epsilon[r0,1]} \{r_2 : BSADF_{r2}(r0) > scv^{\beta T}_{r2} \ldots\ldots\ldots\ldots\ldots 4$$

$$r\hat{}_f = r_{2\epsilon[\inf r_{A\epsilon} + [\frac{s\log(T)}{T,1}]}\{r_2: BSADF_{r2}(r0) > scv^{\beta T}_{r2} \quad \ldots\ldots 5$$

Where;

$scv^{\beta T}_{r2}$ = the 100(1-$\boldsymbol{\beta}_T$)% critical value of the SADF statistic, based on [T_{r2}] periodic observations.

$\boldsymbol{\beta}_T \rightarrow 0$, as the sample size $\rightarrow$infinity.

SADF (r_0) = $\sup_{r2\epsilon[r0,1]}$ {ADF_{r2}};

GSADF (r_0) = $\sup_{r2\epsilon[r0,1]}$ {$BSADF_{r2}(r_0)$.

4. RESULTS AND DISCUSSIONS

4.1: Testing of Multiple Bubbles in NSE

Our argument is on the existence of multiple bubbles in the NSE due to thefinancial crisis of 2007/2008, CBN-MPC assertion of seeming bubbles [57], and the emergence of Covid-19 and other variants globally and its rebound.

Table 4.1: Detection of Multiple Bubbles – SADF and GSADF test

	Right Tailed ADF Tests Sample : 1985M01-2021M12				
	ASITest statistic	Probability	Finite sample critical values		
444 Observations			90%	95%	99%
SADF	12.86919	0.0000	1.126830	1.411247	1.794622
GSADF	12.86919	0.0000	1.973775	2.200729	2.723749

**Right-tailed test*

***Critical values are based on a Monte Carlo simulation on E-views*

Source: E-views 10.0

The SADF and GSADF test from Table 4.1 reveal that at 1%, 5% and 10% level of significance, episodes of multiple bubbles and or explosive pricing exist in the Nigerian Stock Exchange in the study period. This is because the SADF and GSADF t-statistic of 12.86919 is more than its critical values. Thus, we reject the null hypothesis that the stock market follows a random walk and conclude that the Nigerian Stock Exchange had explosive sub periods of exuberances and collapses.

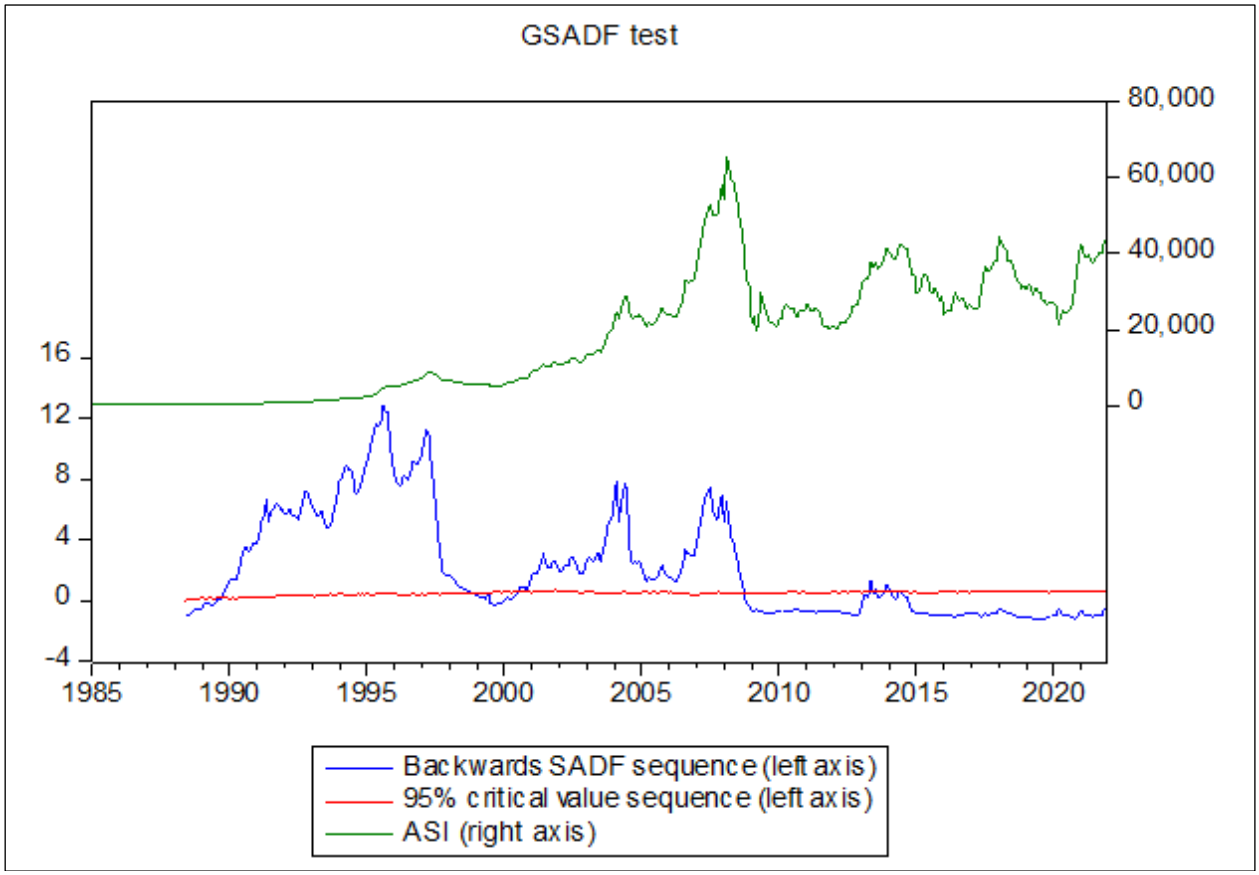

Figure 4.1: Date and Time of Multiple period bubbles in the NSE ASI – GSADF

From Figure 4.1, the Backward SADF statistic was compared with the 95% SADF critical value gotten from the Monte Carlo simulation with 1000 reiterations, and three bubble episodes were identified. The date and time was for the period1989M08 – 2009M09; and the duration of these episodes were more than 1year.The

analysis established specific dates when multiples bubbles existed which were from 1989M08-1998M11; 2000M12-2005M08; and 2006M04-2009M09.

4.2 Discussion of Findings

In the first period, the stock market bubble went from 0.2% to 12.4% in 1995 and collapsed to 0.6% in 1998 with some slight breaks in between. This period's market activities were mostly affected by other stock crashes around the world like the Dow Jones, S&P 500 and the Nasdaq Composite which were associated with both optimism and pessimism of speculative investors and the idea of a new technological age: information technology and biotechnology [65, 66]. In the second period, the market rose from 0.6% to 7.3% in 2004 and collapsed to 1.7% in 2005 due to inefficiencies observed in banking practices and the deadline given by the central bank on the recapitalization policy as well as the insistence on novel corporate governance codes. In the last period, the market rose from 1.3% in 2006 to a peak of 7.5% in 2007 and fell to a -0.8% in 2009. This was as a result of the contagion effect of globalization. That is, the subprime mortgage crisis that emanated from the US, and the issue of margin lending where investors sook loans from banks to invest in the NSE. As a result, stocks were oversubscribed and in less than a year, the NSE was hit by the global financial crisis. Foreign portfolio investors looked for ways to sell-off their holdings to repatriate their funds, crude oil prices fell, the naira depreciated, stock prices fell and non-performing toxic asset were created. This made it quite difficult for margin lending investors to repay their loans and thereafter led to investors' apathy. However, the covid19 pandemic was not seen to have caused any peak or dip in the NSE; and no seeming bubbles were observed too, as suggested by the Central Bank of Nigeria. Our findings agrees with Igbinovia and Igbinovia[3] and Illiyasu*et al.*,[42] that multiple bubbles exist in the NSE.

5. CONCLUSION AND RECOMMENDATIONS

The SADF and GSADF test was utilized to detect multiple bubbles period in the NSE from its inception in 1985M01 to the period 2021M12; based on available data from the Central Securities Clearing System of the Nigerian Stock Exchange and the Central Bank of Nigeria statistics database. The monthly All Share Index was used to proxy for share prices and the number of observations were 444. From the estimation, an initial window size of 42 was chosen and the Monte Carlo simulation with 1000 repetitions was used to generate the critical values. The GSADF test has considerable discriminatory influence and overcomes the drawbacks witnessed in the SADF test; which was unable to detect multiple peaks and collapse of the bubbles. From the simulation, we observed that multiple periods of explosive prices and subsequent collapses exist in the NSE. Furthermore, the date/time stamping criteria of the GSADF process submit evidence of peaks and falls. More specifically, we found the cross-border financial crisis of the 2007/8 subprime mortgage finance that affected stock markets around the world and the issue of margin lending which led to oversubscription of stock and created toxic assets.Based on the above findings, we recommend that investors should consider a monthly re-evaluation of their portfolios to guard against market inefficiencies, asset mispricing and protract recession. Though this may involve high transaction cost, but it is more beneficial to incurring huge economic losses associated with bubbles. Portfolio managers should diversify their assets and include assets that are mostly negatively-correlated. Also, regulatory agencies should promote market information and support regular training of market participants to stem speculations and reduce arbitrage. Overall, well-informed risk management practices should be established to guard against market losses.

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