Driven by Fundamentals or Exploded by Sentiments: Testing for Speculative Bubbles in Emerging Stock Markets

Asra Shaikh* Muhammad Kashif** Mobeen Ur Rehman*** Shafiq Ur Rehman****

Abstract

This study investigates the existence of speculative bubbles in diverse nine emerging markets, which may lead to terrible financial disasters. Therefore, a novel approach of Rtadf (Recursive, Right-tailed Augmented Dickey-Fuller) tests, monthly time-series data (January 2000–July 2021), and Monte-Carlo simulation under Gaussian assumptions is used. Our findings imply that massive growth in China, Indonesia, Malaysia, Pakistan, Taiwan, and Thailand is driven by credit or speculative bubbles rather than fundamentals whereas no bubbles are found in South Korea, India, and the Philippines - (as per Generalized Supreme ADF - GSADF test). Furthermore, in each stock market, these bubbles primarily exist prior to any local and global financial crisis. These findings add to the existing knowledge of the relationship between bubbles and financial crises. Hence, this study suggests the GSADF test could detect an impending financial crisis in any economy, allowing authorities to control or maintain economic and financial stability.

Keywords: Speculative bubbles; emerging markets; Rtadf approach; economic and financial stability.

JEL Classification: C58, G01, G41

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1. Introduction

According to behavioral finance theory, typically a stock market bubble, also known as an asset bubble or speculative bubble, is an unobservable phenomenon caused by a surge in asset prices as a result of an "investor's cognitive-emotional biases" or "exuberant market behavior," as a result of group thinking or herding behavior (Gali, 2014; Liaqat et al., 2019; Kashif et al., 2021). These financial bubbles have been the most important academic topic throughout history because they are used to predict financial crises since the longevity of speculative bubbles often leads to terrible financial disasters. However, quantifying such bubbles is difficult yet critical since public funds are more frequently trapped in these types of financial hurricanes (Ghosh, 2016b). Therefore, upfront bubble detection is one of the holy grails in financial markets as it manifests serious implicative effects on an economy, and may distort or cause a misrepresentation of a real economy affecting the output growth, investment prospects, anticipated inflation, and collective expenditure (Joarder et al., 2014). In such a case, these deviations in asset prices from their true intrinsic value indicate the existence of bubbles and that market has lost its effectiveness (Çağlı & Mandacı, 2017). However, a subsequent increase in stock prices is not the only reason for the bubble, other factors may also cause this phenomenon.

These bubbles may manifest in three folds: Firstly, it could be natural that appear on fiat money because the overconfidence of financial investors often stems from financial brokers or agents. Secondly, it may arise due to informational monopolies in which some people or firms have inside information and they take benefit of this information by manipulating other investors and artificially increasing the prices of desired stock so they can beat the market. Lastly, political alliances along with some running elites provoke major economic events which in turn leads to an economic bubble (Shleifer, 2000; Bansal & Yaron, 2004; Jimenez, 2011). Therefore, a vast amount of research has been devoted to investigating the presence of asset pricing bubbles in different stock markets (Yu & Hassan, 2010b; Chang et al., 2016; Lee & Phillips, 2016; Caspi & Graham, 2018; Zeren & Yilanci, 2019; Nazir et al., 2020).

Shortly, the incredible progress of emerging markets grabbed the attention of academic researchers and financial investors all around the world. According to the Wall Street article, emerging markets have become modern-day gold rush as their share has recently surpassed the developed market share in just the past 12 months (Weil, 2021). However, this incredible progress is somewhat inexplicable. No doubt, the financial asset prices of these emerging markets are booming but when we look at the public financing of these markets, it is turning from bad to worst (Bulwark, 2021). Given this fact, these markets are fueled by unprecedented global liquidity which occurred in response to the pandemic. The Federal Reserve and European Central Bank started printing more and more money, have pushed the world interest rates to the lowest possible level which in turn persuaded financial investors from around the world to stretch for the yield by taking more risk, especially through investing in emerging markets (Bulwark, 2021).

Hence, the financial asset prices of emerging markets are not truly reflecting their deteriorating fundamentals or performance. Therefore, it is important to investigate whether the sharp increase in the emerging stock market indexes and market performance over the last decade is merely a speculative bubble or actual performance based on stock market fundamentals. In this regard, few studies have been conducted to document the single or multiple episodes of speculative bubbles in emerging markets (Ghosh, 2016b; Liu et al., 2016; Mitra & Chaudary, 2016; Almudhaf, 2018; Tran, 2017; Nazir et al., 2020; Korkmaz et al., 2021). However, no one has conducted research on testing speculative bubbles in (nine) emerging markets altogether to provide a comprehensive view to answer the main research questions of this study. 1. Are these emerging markets safe or riskier for financial investors' investments? 2. Are there any speculative or asset pricing bubbles in (nine) emerging stock markets? 3. Are these (Rtadf) able to predict the financial crisis led by speculative bubbles in these emerging stock markets?

To the best of our knowledge, the present study is unique as it contributes to scarce literature about date stamping single or multiple episodes of speculative bubbles in (nine) emerging markets (Including China, India, Indonesia, Korea, Malaysia, Philippines, Taiwan, Thailand – MSCI Emerging market index) in addition to Pakistan (which recently reclassified as a frontier market but shares the most characteristics of the emerging market) to provide a comprehensive picture. Secondly, this study has considered the most recent time-series (monthly) secondary data from Jan 2000 to July 2021. Since 2000, 80% of the data has been available. As a result, this sample time period is chosen. Furthermore, this study compares various Recursive - Rtadf tests, such as Supreme ADF -SADF (Phillip et al., 2011) and Generalized SADF -GSADF, (Phillip et al., 2015), to see which test can better predict the financial crisis led by speculative bubbles in emerging stock markets. Lastly, Monte Carlo simulation is used for the p-values estimation (potentially more robust even in the presence of nonstationary volatility in the market) under the assumption of Gaussian innovations in emerging stock markets.

2. Literature Review

`The first bubble ever recorded in economic history was skyrocketing price of Tulip bulbs in the 1630s known as Tulip Mania or Tulip bubble, followed by the Mississippi bubble (1927); Asian Country's estate and stock market bubble (1992-1997); Dot-Com or Tech bubble (2000), Real-estate or Sub-Prime Mortgage Housing bubble (2008-2012); Greek Government Debt bubble (2011) and Bitcoin bubble (2015) are among the most important bubble examples in history (Zeren & Yilanci, 2019) These asset pricing bubbles are divided into two categories. For instance, rational bubbles and irrational bubbles. The irrational bubble is well explained by behavioral finance using the perspective of game theory by combining the concepts of investors' psychology and factors of the environment. This includes the Noise trader model, Herding behavior model, Fashion trend model, etc. Conversely, rational bubble theory states, that a rational bubble occurs whenever the true price of an asset deviates progressively more quickly from its economic fundamentals. The growth of a rational bubble reflects the presence of rational expectations of an investor regarding the future increase in asset prices.

This idea of identification of a rational bubble was first proposed by Blanchard (1979a) using an overlapping generation model followed by various subsequent models based on rational expectation theory. According to this theory, past outcomes influence future outcomes, and it also laid down a theoretical foundation to measure the rational bubble. For instance, if the current price elasticity is compared to the next period's expected price elasticity and if the resulted value is smaller than 1 then there must be a forward solution that considers the condition of stationarity and therefore rational expectation is conditional on the relationship of current and future expected prices (Blanchard, 1979b). According to Chan et al. (1998), rational expectation also reveals the 'rational bubble law'. Rational bubbles mean that the long-run relationship between stock prices and dividends disappears or that an increase in stock prices moves over long periods, whereas the bubbles resulting from an increase in asset prices unexpectedly explode due to some specific events. As many individuals or firms involved in profit speculation grow, rational behavior devolves into what is known as a bubble. A bubble subsequently rises in price for a certain period before its collapse, while a prolonged negative bubble is referred to as a collapse. Therefore, Blanchard and Watson (1982) claimed this fact, speculative rational bubbles are not led by investors' rational behavior due to which it is more difficult to find such a potentially high-power procedure that can accurately detect rational bubbles in stock markets.

In retrospect, earlier rational bubble tests assume that rational bubbles are linear illustrating the fact that if a bubble exists in any market it will always exist and would not collapse or reoccur but in reality, this assumption does not hold. Thus, empirical identification of the rational stock market bubble in real-time has practically been a big challenge. Many researchers have proposed various statistical testing methods such as the Variance bound test (Shiller, 1981b); Co-integration test (Diba & Grossman, 1988a); Specification test (West, 1988) followed by Non-Linear testing models (Evans, 1991a); Generalized dickey fuller test (Hall et al., 1999) to test the presence of stock market bubbles over the period but due to severe criticism, loopholes and biases, these methods are not substantially supported by economists in general (Diba & Grossman, 1988b; Evans, 1991a; & Caspi, 2017).

More recently, a new advanced testing method based on the Recursive- right tail augmented dickey fuller (Rtadf) unit root test has been developed by Phillip et al. (2011) & Phillip et al. (2015) which enables us to not only identify the bubble but to also date stamp its occurrence. The significant advantage of this test is that it allows for accounting for nonlinear patterns and multiple breaks during investigating multiple bubbles in the market. These tests consider changes in the generalized dickey-fuller test by considering the null hypothesis of unit root and alternative as mild explosive behavior with the use of the Monte-Carlo simulation technique to estimate the p-values. Due to this, these rolling and recursive tests are also found more robust and potentially more powerful than standard test methods.

Since the global financial crisis of 2008 triggered by the U.S sub-prime mortgage crisis, there has been a growing literature in more developed and emerging markets exploring the existence of financial bubbles and their potential consequences with the help of using above-mentioned strategies. In this regard, a couple of studies have documented date stamping of single or multiple episodes of bubbles (Yao & Luo, 2009; Yu & Hassan, 2010b; Caspi, 2014; Chang et al., 2016; Liu et al., 2016b; Rasekhi et al., 2017; Madjumerd et al., 2017; Caspi & Graham, 2018; Zeren & Yilanci, 2019; Liaqat et al., 2019). However, the recent shift of financial investors towards emerging markets over developed ones has attracted the interest of academic researchers everywhere to investigate whether or not the emerging market's sudden rise is consistent with its actual performance as measured by stock market fundamentals.

Hence, the present study contributes to the literature as follows: Firstly, this study aims to investigate the date stamping of single or multiple episodes of speculative bubbles in various emerging markets. Secondly, China, India, Indonesia, Korea, Malaysia, Philippines, Taiwan, and Thailand stock emerging markets are considered in addition to Pakistan, using monthly time series secondary data from the period of (Jan 2000 – July 2021). Moreover, this study considers advanced Recursive – (Rtadf) models: Supreme ADF (SADF, Phillip et al., 2011) and Generalized SADF -GSADF (Phillip et al., 2015) with Monte Carlo simulation, under the assumption of Gaussian innovations to detect asset pricing bubbles.

2.1 Theoretical Background

The current equilibrium price (under the conditions of no-arbitrage and risk neutrality assumption) is equal to a future discounted expected outcome.

$$P_t = 1/R_{t+1}E_t(P_{t+1} + D_{t+1}) \tag{1}$$

In which, Pt is the actual stock's price (t), Dt+1 is the dividends received for the maintenance of stocks from t-1 to t, Rt+1 is the gross discount rate and Et represents expectations at time t. later, a log-linear approximation of equation (1) is considered (Campbell and Shiller, 1988; Cochrane, 2001).

$$P_t = k + \rho p_{t+1} + (1+\rho)d_{t+1} - r_{t+1} \tag{2}$$

In which, log price to dividend obtained is as follows:

$$k = -\log \rho - (1-p)\log(\frac{1}{1-\rho})$$

This equation (2) represents the first-order difference which can be rewritten as:

$$p_t = p_t^f + b_t \tag{3}$$

In which, expectations and log-linear approximation lead to equation (4) using forward iterations.

$$p_t - d_t = \frac{k}{1-\rho} + \sum_{i=0}^{\infty} \rho E_t(\Delta d_{t+1+i} - r_{t+1+i}) + \underrightarrow{\lim}_{\infty} \rho^i E_t(\mathrm{p}_{t+i} - d_{t+i}) \tag{4}$$

Equation (4) can be further broken down into two equations:

$$p_t - r_t = f_t + b_t \tag{5}$$

$$f_t = \frac{k}{1-\rho} + \sum_{i=0}^{\infty} \rho E_t(\Delta d_{t+1+i} - r_{t+1+i}) \tag{6}$$

This equation (5) shows the most important component i.e. rational bubble in terms of the growth rate of expected profits. Where,

$$b_t = \underrightarrow{\lim}_{\infty} \rho^i E_t(\mathrm{p}_{t+i} - d_{t+i}) \tag{7}$$

In a situation, where a strictly positive rational bubble occurs, investors will pay an additional price i.e. more than the base price of the stock because they have a firm belief that their expectations will be compensated in future expected prices. This behavior of investors is aligned with the hypothesis of rational expectation theory (Caspi, 2014). Here one thing should be noted, in equation (4) variables (Pt - dt) can be computed through (ft and bt) as discussed above. Ft can be determined through . The explosive evidence of (Pt - dt) can exhibit strong evidence of an asset pricing bubble i.e. (bt = 0) only if dt and rt both are of maximum co-integration at the first order of difference.

This mild explosive behavior process was introduced by Philip and Mangdalinos (2007) which can be helpful in financial boom modeling. However, co-integration in dividends and stock prices fails to examine the periodic fading of stock bubbles because of certain biases and kurtosis (Evans, 1991a). Therefore, Philip et al. (2011) and Phillip et al. (2015) suggested the framework of advanced recursive (Rtadf) tests to detect single or multiple bubbles in a more sophisticated econometric way because these co-integration techniques or normal unit root tests cannot identify periodical fading of bubbles.

3. Research Methodology and Data Collection

This empirical study is based on the framework suggested by Philip et al. (2011) and Phillip et al. (2015), also regarded as an advanced recursive approach (Rtadf tests) to detect single or multiple bubbles in emerging stock markets. The sample size of this study includes the MSCI-Emerging stock markets such as China (Shanghai Stock Exchange– CSI-SSE-50 index); India (Nifty 50 index); Indonesia (KOMPAS 100 index); Korea (KOSPI 100 index); Malaysia (FTSE BURSA Malaysia 30 index); Philippines (PSEI 30 index); Taiwan (Taiwan Stock Exchange 100 index); Thailand (Thailand 100 index) in addition to Pakistan (KSE 100 index) – (Pakistan recently classified as Frontier Market but shares major characteristics of the emerging market).

In this regard, Philip et al. (2011) proposed a model known as the Sup ADF (SADF) test, which comprises a recursive right-tail unit root ADF that can date-stamp (detect the exuberance, duration, and collapse date) single asset pricing bubble. For this purpose, we also have the Chow test and Cumulative Sum test but the SADF test is found to be more efficient and fits best in structural failures while discovering bubbles. The random step process of this test is as follows:

$$y_t = dT^{-\eta} + \theta y_{t-1} + e_t, e_t \sim N(0, \delta^2), \theta = 1 \tag{8}$$

Where yt is the main variable (price-to-dividend ratio), d is constant, n is the coefficient where the sample size (T) extends to infinity and e is the error term. This right-tailed test by considering subsequent autoregressive properties can be written as:

$$y_t = \mu + \delta y_{t-1} + \sum_{i=1}^{p} \phi_i y_{t-i} + e_t \tag{9}$$

Where y_t is the main variable (price-to-dividend ratio), μ is constant, δ $\mathbf{r_{1,} r_2}$ sign is the approximate coefficient of ADF statistics, p means the maximum number of intervals, is the coefficient of differenced term and e is the error term. It should be noted that this test calculates the ADF statistic with $ADF_{r1, r2}$. In this regard, the normal range is from 0 to 1. The size of the window in regression is represented by r_w i.e. $r_w = r_2 – r_1$ (Caspi, 2014). The right-tailed test calculates the ADF statistic recursively and regression samples involve rolling windows to test rational bubbles based on the following hypothesis:

- H0 = $\delta_{\mathbf{r1, r2}} = \mathbf{0}$, Series has no rational bubble along with the unit root.
- H1 = $\delta_{\mathbf{r1, r2}} > \mathbf{0}$, Series have mildly explosive behavior or rational bubbles along with the unit root.

Unlike the normal left-tailed unit root tests where these r_1 and r_2 statistics are fixed and are placed as the first and last observation in the sample where $r_w = r_0 = 1$. Hence, the divergence in alternative Rtadf tests is about the replacement of ADF statistics of r_1 and r_2. This can better be understood with the following versions of the tests:

In the standard ADF unit root test, these r_1 and r2 statistics are fixed and are placed as the first and last observations in the sample where $r_w = r_0 = 1$. This can be seen from the below-given figure (1). Therefore, this test fails to identify the periodic collapse of bubbles in any market.

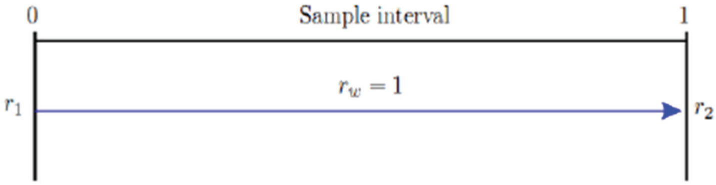

Figure 1: The process of ADF (Source: Caspi, 2014)

The Supreme ADF test is based on the computation of ADF statistics where the initial point is constant i.e. $r_1 = 0$ in all windows, but eventually, the size of the window increases at each stage at a specific rate. Accordingly, ADFr_2 represents the ADF value at each level of estimation, also found to be significant in detecting a single bubble such as:

$$SADF(r_0) = \sup\{ADF_{r2}\}, r_2 \in [r_0, 1] \tag{10}$$

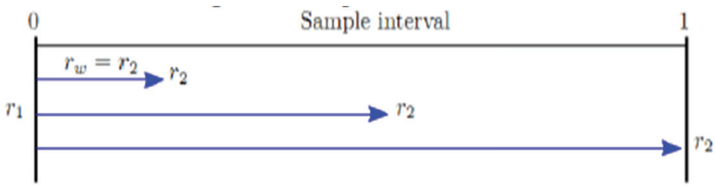

Figure 2: The process of Supreme ADF (Source: Caspi, 2014)

The Generalization of SADF statistics emerges through the GSADF strategy. In this test, the computation of ADF statistic of the initial point of estimation can be both fixed and variable [see Figure 4]. In case of multiple booms and collapse failures, the Generalized Sup ADF (GSADF) test is more appropriate and powerful. Moreover, among all the ADFr_2 statistics GSADF statistics are supremely related to each window such as:

$$GSADF(r_0) = \sup\{ADF_{r1}^{r2}\}, r_2 \in [r_0, 1] \,\&\, \mathrm{r}_1 \in [0, r_2 - \mathrm{r}_1] \tag{11}$$

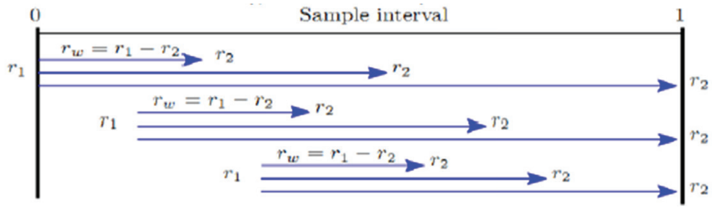

Figure 3: The process of Generalized ADF (Source: Caspi, 2014)

Hence, for the empirical testing, these regression models were used to derive Supreme ADF (SADF) and Generalized SADF (GSADF) statistics with the inclusion of a constant. On the other hand, Phillips et al. (2015) propose a backward sup ADF (BSADF) test to detect the origin and termination date of a bubble. The direction of the tests is reversed in the tests. The origination and termination date of a bubble can be determined based on the BSADF statistic. Additionally, secondary data is obtained from the official database of the Refinitiv Eikon Database. The minimum window size considered is 32 as per the general rule of $\lambda 0 = 0.01 + 1.8 / \sqrt{T}$ (Phillips et al., 2015). The p–values of the statistics are computed using Monte Carlo simulations under the assumption of the Gaussian method which is expected to be found robust even in the presence of nonstationary volatility in the market. Moreover, it should also be noted all simulations are executed using Rtadf (E-views) Add-in (Caspi, 2015) rested on 1000 replications with a sample size of 259 observations.

3.1 Data Collection

In our implementation for the illustrative analysis, the empirical data employed is monthly time series including Price per share (P) and Dividend per share (DPS) of selected listed companies of the following MSCI emerging stock markets along with Pakistan. The sample includes the following stock market indexes: China – (Shanghai Stock Exchange–CSI-SSE-50 index), India – (Nifty 50 index), Indonesia – (KOMPAS 100 index), Korea – (KOSPI 100 index), Malaysia – (FTSE BURSA Malaysia 30 index), Pakistan - (KSE 100 index), Philippines – (PSEI 30 index), Taiwan – (Taiwan Stock Exchange 100 index) and Thailand – (Thailand 100 index). The secondary data is gathered from the official database of Refinitiv Eikon Database from the period of (Jan 2000 to July 2021) of the major (most commonly used) stock indexes of emerging stock markets, as well as according to the availability of required data. However, to reflect the relationship between stock prices with its market fundamentals, the Price to dividend ratio is considered and computed by taking the cross averages of listed companies' data (Caspi, 2017).

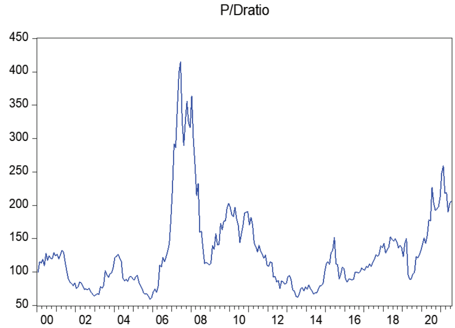

Figure 4: P/D ratio (China)

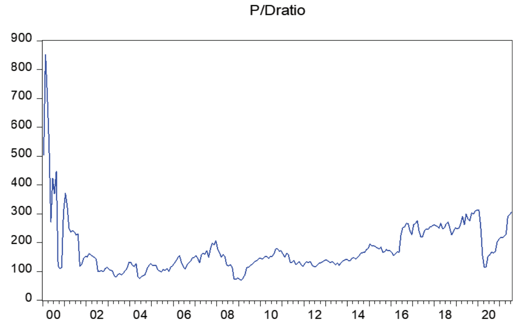

Figure 5: P/D ratio (India)

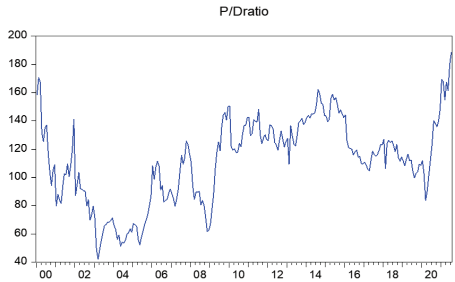

Figure 6: P/D ratio (Indonesia)

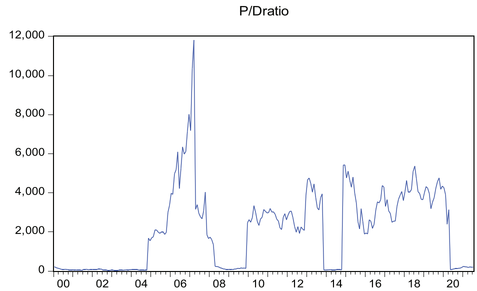

Figure 7: P/D ratio (Korea)

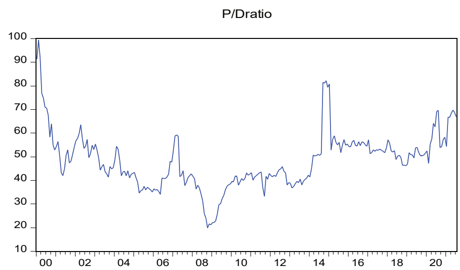

Figure 8: P/D ratio (Malaysia)

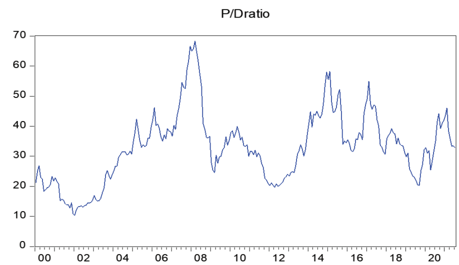

Figure 9: P/D ratio (Pakistan)

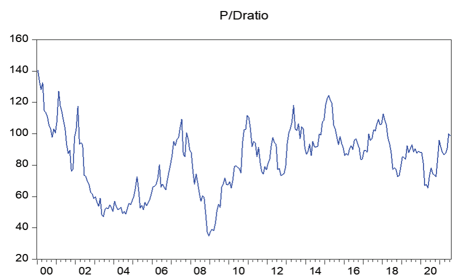

Figure 10: P/D ratio (Philippines)

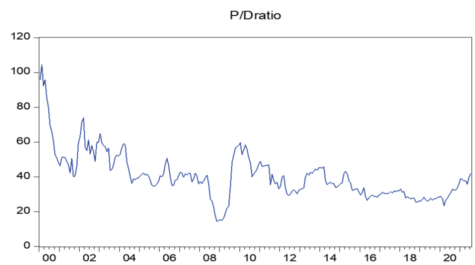

Figure 11: P/D ratio (Taiwan)

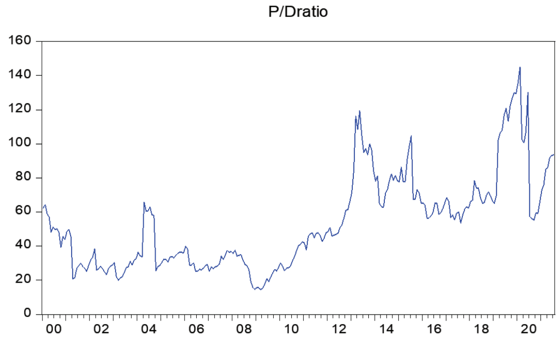

Figure 12: P/D ratio (Thailand)

Following the studies of Philips et al. (2011) and Phillip et al. (2015), the above figures (4-12) show the testing data of the Price to a Dividend ratio of all the listed companies in emerging markets. During the sample period of (Jan 2000 – July 2021), dramatic abrupt fluctuations can be detected easily in all the index's price-to-dividend ratios with the illustrational evidence of multiple shocks or bubbles in these markets.

4. Results and Discussion

This empirical study has considered bubble discovery tests based on the volatility of right-tailed ADF tests (Rtadf) in which the null hypothesis is a unit root (no bubbles) and the alternate hypothesis exhibits the existence of bubbles in the stock market.

Table 1

Recursive Right-Tailed- ADF Tests Results

STOCK MARKETS	SADF	GSADF
Shanghai SE 50 (China)	5.96 (0.00)***	6.65 (0.00)*
CV - 99 % Level	1.96	2.75
CV - 95 % Level	1.46	2.11
CV - 90 % Level	1.18	1.92
NIFTY 50 (India)	-2.03 (0.99)	1.73 (0.14)
CV - 99 % Level	1.96	2.75
CV - 95 % Level	1.46	2.11
CV - 90 % Level	1.18	1.92
KOMPAS 100 (Indonesia)	4.22 (0.00)***	4.22 (0.00)***
CV - 99 % Level	1.96	2.75
CV - 95 % Level	1.46	2.11
CV - 90 % Level	1.18	1.92
KOSPI 100 (Korea)	-1.64 (0.98)	1.79 (0.12)
CV - 99 % Level	1.96	2.75
CV - 95 % Level	1.46	2.11
CV - 90 % Level	1.18	1.92
FTSE BURSA (Malaysia)	-1.52 (0.93)	1.02 (0.10)*
CV - 99 % Level	0.99	1.77
CV - 95 % Level	0.51	1.28
CV - 90 % Level	0.29	1.02
KSE 100 (Pakistan)	1.73 (0.01)***	2.09 (0.06)*
CV - 99 % Level	1.96	2.75
CV - 95 % Level	1.46	2.11
CV - 90 % Level	1.18	1.92
PSEI 30 (Philippines)	-1.23 (0.96)	0.84 (0.65)
CV - 99 % Level	1.96	2.75
CV - 95 % Level	1.46	2.11
CV - 90 % Level	1.18	1.92
TAIWAN 100 (Taiwan)	-1.48 (0.93)	1.20 (0.05)**
CV - 99 % Level	0.99	1.77
CV - 95 % Level	0.51	1.28
CV - 90 % Level	0.29	1.02
Thailand 100 (Thailand)	0.26 (0.44)	4.91 (0.00)***
CV - 99 % Level	1.96	2.75
CV - 95 % Level	1.46	2.1
CV - 90 % Level	1.18	1.92

This table reports the results of Emerging (nine) markets from the period of Jan 2000- July 2021 of two right-tailed (ADF) regression models with the P-values computed through Monte Carlo simulations based on 1000 replications considering an initial window size of 32 (sample size 259 observations) through E-views (Rtadf) Add-ins. (***) represents 1%, (**) represents 5% and (*) represents a 10% level of significance respectively.
(Source: Author's Calculations)

Table (1) suggests strong evidence of the existence of rational bubbles in China, Indonesia, Malaysia, Pakistan, Taiwan, and Thailand stock markets from (Jan 2000 to July 2021). The null hypothesis (unit root or no bubbles) is rejected as the GSADF statistics values are found statistically significant at 1%, 5%, or 10% levels also greater than its critical values as computed through Monte-Carlo simulation. However, South Korea, India, and the Philippines exhibit no evidence of significant rational bubbles. The results, in other words, suggest the GSADF test is found to be a better model than the SADF test in detecting past multiple bubbles in diverse emerging markets. Moreover, for the date stamping Backward (SADF) statistics sequence with 95%, the critical value sequence is used from the Monte Carlo simulation of 1000 replications.

4.1 Pakistan

Regarding Pakistan, strong evidence of multiple bubbles is found in (KSE -100 index) from the period of Jan 2000- July 2021 as SADF and GSADF t-statistics are found greater than all critical values and are also found statistically significant at 1% under the Monte Carlo simulations.

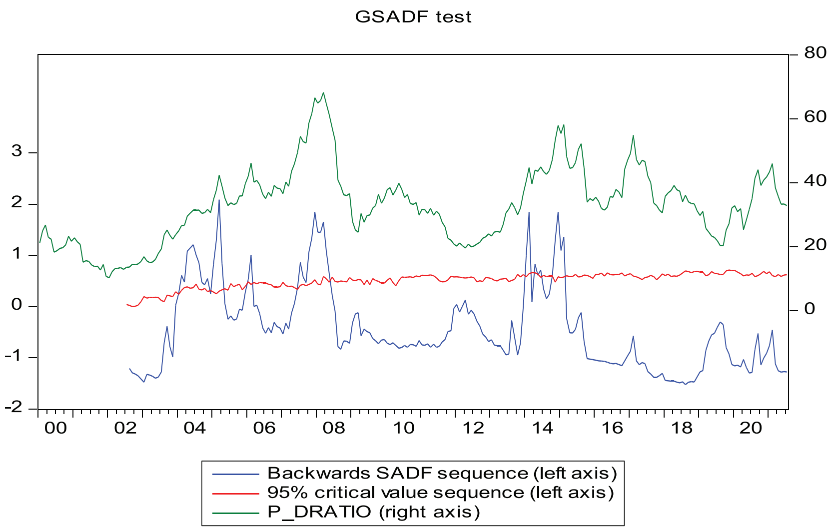

Figure 13: GSADF (Pakistan)

The visual inspection of the date stamping procedure can be seen from the above graphical illustration of the GSADF test. In which, the blue line represents BSADF (Backward SADF) sequence and the red line shows the threshold sequence at 95% critical value sequence. Figure 13 shows the BSADF sequence does cross the threshold rejection line at different times stating the existence of three multiple bubbles. Firstly, the BSADF sequence stays above the threshold from 2003 to 2005. This bubble indicates the bullish trend which continued in terms of market capitalization, turnover, and shares traded as a result of privatization moves and liberalization measures after a decade. Secondly, the run-up phase of another big bubble can be seen for about months in and around 2007-2008 mainly caused due to the assassination of Prime Minister - Mohtarma Benazir Bhutto followed by the global financial crisis of (2008), political upheaval, and local crisis. Lastly, another big bubble can be seen during June 2013, this happened due to the excitement created ahead of Pakistan's reclassification into the MSCI emerging market and panic selling of (heavy-weighted by our local investors as a result of disappointment (Dawn, 2017 & Liaqat et al., 2019).

4.2 China

Regarding China, again strong evidence of multiple bubbles is found in (Shanghai SE 50 index) from the period of Jan 2000- to July 2021 as SADF and GSADF t-statistics are found greater than all critical values and are also found statistically significant at 1% under the Monte Carlo simulations.

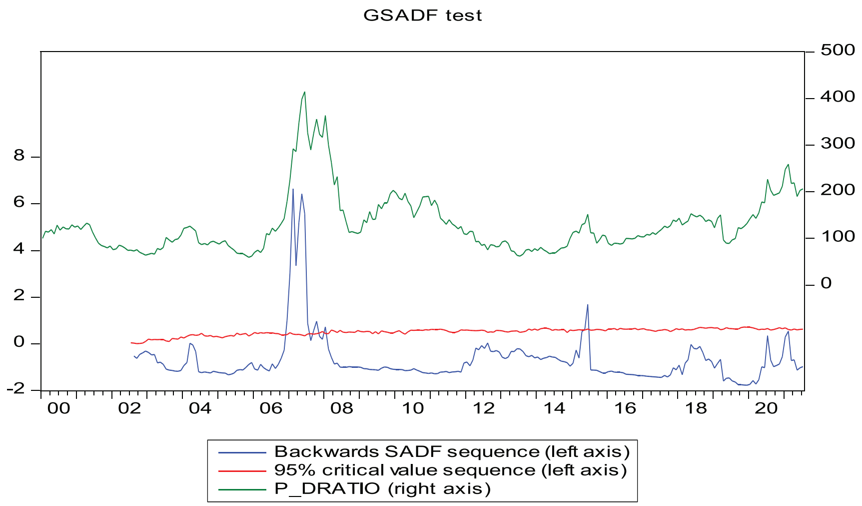

Figure 14: GSADF (China)

Figure 14 shows that the BSADF sequence does cross the threshold rejection line at different times stating the existence of two multiple bubbles in the market of China. Firstly, the BSADF sequence stays above the threshold from 2007 to 2008 during the period of the subprime crisis. Moreover, the situation got worst when the Chinese stock market bubble in 2007 also hit the economy when the SSE Composite index of the Shanghai stock exchange collapsed by 9% due to an unpredicted selloff. This was unfortunately one of the largest dips in the history of 10 years, which triggered a major drop in worldwide stock markets (Chang et al., 2016). Another bubble occurred around the period of 2015, when inexperienced people started investing in the Chinese stock market especially in leveraged instruments due to the changes in Government policy to solve its debt issue, this was followed by the market collapse.

4.3 Indonesia

Indonesia also exhibits strong evidence of multiple bubbles in the Kompas 100 index from Jan 2000 to July 2021) as SADF and GSADF t-statistics are found greater than all its critical values, and are also found statistically significant at 5% and 1% respectively under the Monte Carlo simulations.

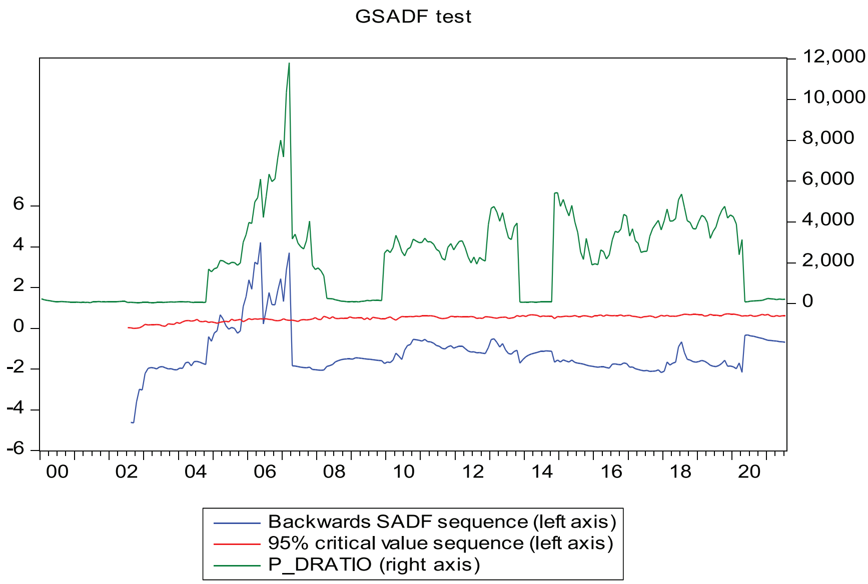

Figure 15: GSADF (Indonesia)

Figure 15 shows that the BSADF sequence does cross the threshold rejection line at different times stating the existence of two multiple bubbles in the market of Indonesia. Firstly, the BSADF sequence stays above the threshold from 2005 to 2006 and 2006 to 2007 respectively. These multiple phases of bubbles occurred due to the significant events which happened in the Indonesian stock market. This includes the stock options which were launched in October 2004. Moreover, the Surabaya stock exchange also merged with the Jakarta stock exchange in 2007 to increase the operational efficiency of the stock market. These events were then followed by the subprime Global financial crisis (Chan & Woo, 2008; Chen & Xie, 2017;Almudhaf, 2018).

4.4 Korea

Korea exhibits no evidence of the rational bubble in the Kospi 100 index from Jan 2000 to July 2021as SADF &GSADF t-statistics are found smaller than all its critical values, and is also found statistically insignificant even at 10% under the Monte Carlo simulations.

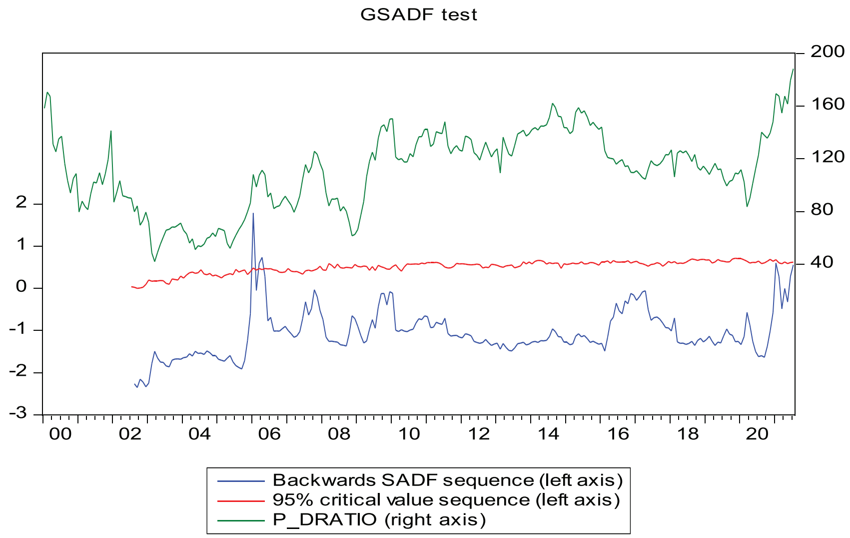

Figure 16: GSADF (Korea)

Figure 16 shows that the BSADF sequence does cross the threshold rejection line once but this bubble is found to be insignificant as the GSADF statistic value is found to be smaller than its critical value [See Table1]. Our findings suggest that the market seems to be efficient and the results are aligned with Hu (2011).

4.5 Malaysia

Malaysia also shows some empirical evidence of multiple bubbles in the FTSE BURSA index from Jan 2000 to July 2021 as only GSADF t-statistics are found greater than its critical value, and is also found statistically significant at 10% respectively under the Monte Carlo simulations.

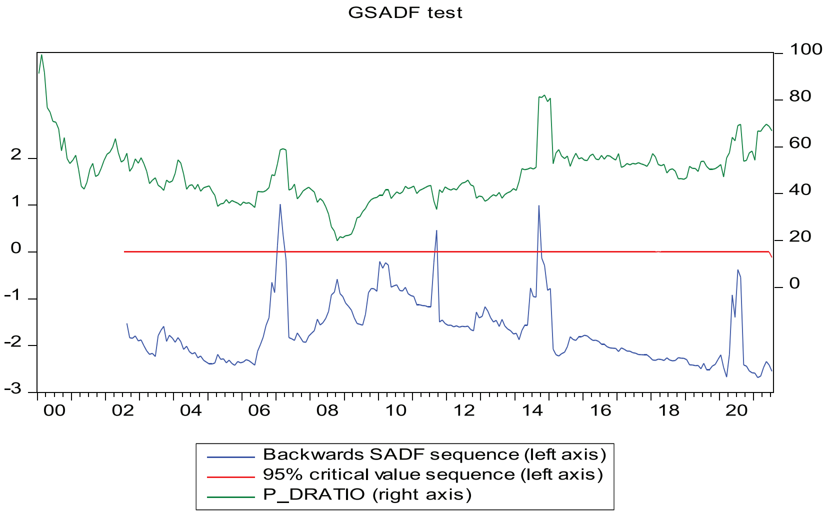

Figure 17: GSADF (Malaysia)

Figure 17 shows, the BSADF sequence does cross the threshold rejection line multiple times stating the existence of three bubbles in the market of Malaysia. The first bubble of Dec 2006 occurred due to the stock overreaction behavior in the pre-crisis period followed by the subprime mortgage crisis of 2007-2008. Similarly, the second bubble appeared in the time period of 2011-2012 whereas the third bubble in 2015-2016, indicating that Malaysia's market is also less efficient followed by a certain behavioral bias (Hu, 2011;Chen & Xie, 2017; Szulczyk et al., 2018).

4.6 Philippines

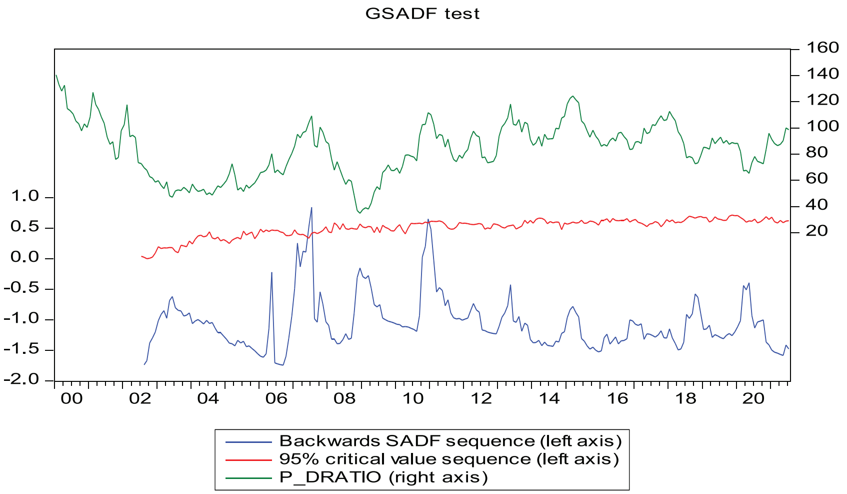

Figure 18: GSADF (Philippines)

Figure 18 shows that the BSADF sequence does cross the threshold rejection line once as one can see a small blip also found to be insignificant. As a result, no reasonable bubbles can be discovered in the Philippines (PSEI 30 index) because this market is still underdeveloped. Overall our results regarding the Philippines market are consistent with Glindro and Delloro (2010) and Hu (2011).

4.7 Taiwan

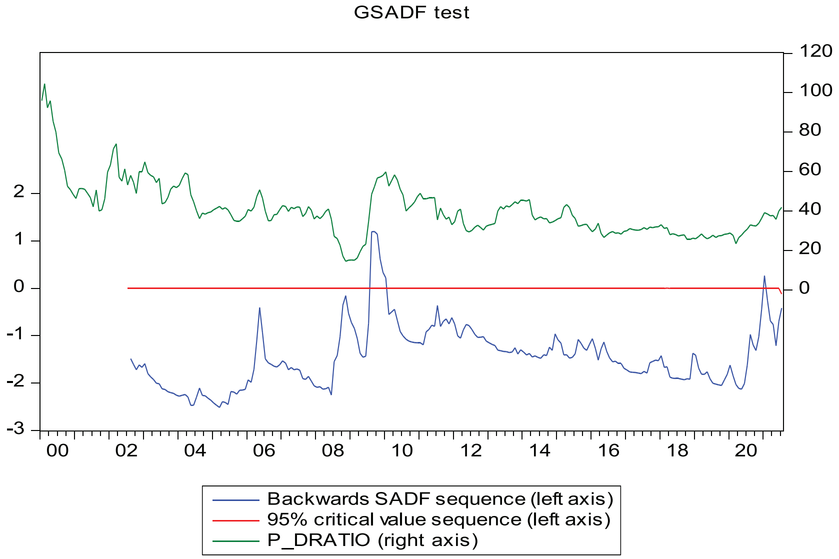

Figure 19: GSADF (Taiwan)

Figure 19 shows the results of Taiwan, which suggest strong evidence of a single bubble due to the subprime mortgage crisis in the Kospi 100 index) as GSADF t-statistics are found greater than all its critical values, and is also found statistically significant at 5% respectively under the Monte Carlo simulations.

4.8 Thailand

Thailand also suggests strong evidence of the single giant bubble in the Thailand 100 index from Jan 2000 to July 2021 as GSADF t-statistics are found greater than all its critical values, and is also found statistically significant at 1% respectively under the Monte Carlo simulations.

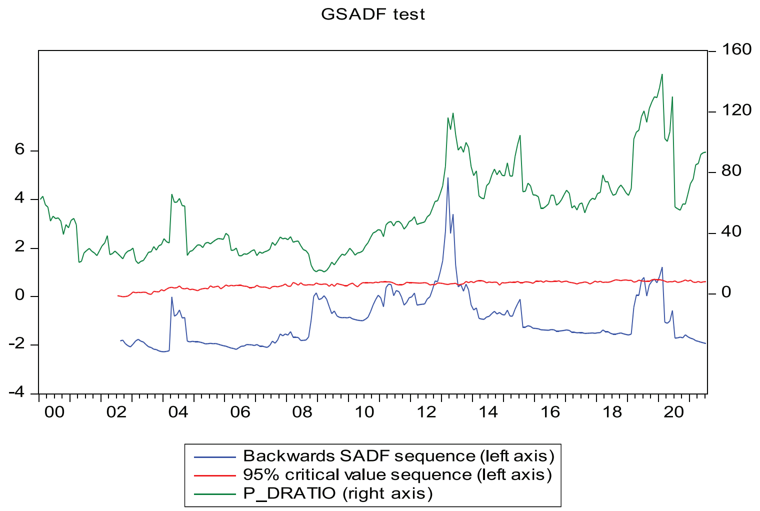

Figure 20: GSADF (Thailand)

Figure 20 shows that the BSADF sequence does cross the threshold rejection line once as one can see a big spike that is also found to be significant. This bubble (2012-13) occurred because of ultra-low interest rates in the US, Europe, and Japan which surged 'hot money' flow in emerging markets including Thailand. Moreover, abnormally cheap credit conditions caused property (Condo Houses) prices to inflate which together created the perfect conditions for the construction of bubbles in this market (Colombo, 2014; Szulczyk et al., 2018).

4.9 India

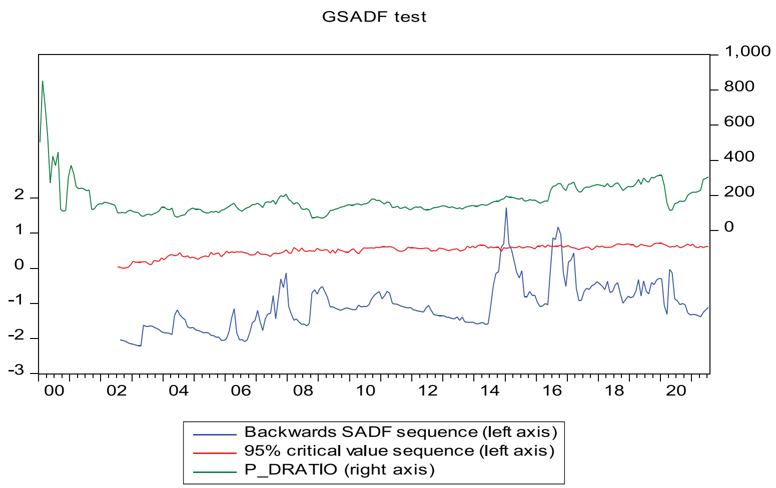

Figure 21: GSADF (India)

Whereas, Figure 21 shows the BSADF sequence does cross the threshold rejection line twice in the Nifty – 50, Indian stock market, indicating these spikes as bubbles but these bubbles are found to be insignificant. Moreover, the GSADF statistic value is found to be smaller than its GSADF critical value, which ensures that this market is efficient and stable as behavioral bias is declining in this market (Mitra & Chaudhuri, 2016; Singh et al., 2018).

5. Conclusion

For the past 20 years, the central banks have been happily causing bubbles in stock markets by printing more and more money at ever-lower interest rates to attract more investments. Since the global financial crisis of 2008, emerging markets have been the scene of a modern-day gold rush for investment returns but these markets are also fueled by unprecedented global liquidity in response to the pandemic, making them far riskier. Therefore, the presence of speculative bubbles in (nine) emerging economies including Pakistan is explored in this study using (advanced) recursive right-tailed tests such as SADF (Phillip et al., 2011) and GSADF (Phillip et al., 2015). The obtained results confirmed that incredible growth in China, Indonesia, Malaysia, Pakistan, Taiwan, and Thailand is driven by ballooning credit and speculative pricing bubbles; both herding and cognitive error is negligibly present in these markets as a result of investor sentiments (Hu, 2011; Colombo, 2014; Chang et al., 2016; Chen & Xie, 2017; Almudhaf, 2018;Szulczyk et al., 2018; Liaqat et al., 2019; Kashif et al., 2021). The findings support the rational bubble law. Hence this study confirms, investing in these emerging markets including Pakistan nowadays is far riskier than investing in any other market. As a result, global financial investors should exercise greater caution before making any investment decisions, as these emerging markets' financial asset prices do not accurately reflect their deteriorating fundamentals or performance.

Moreover, the presence of such (multiple) speculative bubbles in these emerging stock markets may lead to disastrous financial crises such as recession or even in some cases depression. Therefore, financial bubbles are often used to predict financial crises since the longevity of speculative bubbles leads to terrible financial disasters. In this regard, the findings of date stamping of these bubbles through (BSADF) statistics also indicate both local and global financial crises, with bubbles appearing in several emerging markets, particularly before the global financial crisis of 2008. Similarly, the effect of the local crisis can be observed through multiple bubbles that are found in the stock market China-driven by leverage and loose credit cycle before the Chinese crisis period (2015) and in Thailand before the Thailand Property Crisis (2013). Hence, the findings revealed many financial crises are followed by various speculative bubbles in these markets. On the other hand, the stock markets of Korea and India seem to be more efficient and more stable as behavioral bias is declining to a great extent in these markets, thus no significant bubbles are found in these stock markets (Hu, 2011; Mitra & Chaudhuri, 2016 & Singh et al., 2018). Besides this, no speculative bubbles are found in the market of the Philippines too because this market is still underdeveloped

(Glindro & Delloro, 2010; Hu, 2011).

Overall our findings suggest that bubbles are an important estimator of a financial crisis because the presence of bubbles seeds financial and macro-economic instability in any economy. It is also evident from our analysis; that many financial crises are followed by speculative bubbles in emerging markets. Thus, an advanced (GSADF) test that can accurately detect multiple bubbles can be used as the earliest cautionary measure of a forthcoming financial crisis in any stock market.

5.1 Practical implications

The formal analysis of the emerging stock market behavior and patterns may aid domestic and international investors in their investment management decisions. They should exercise greater caution before making any investment decisions, as the financial asset prices in these emerging markets do not accurately reflect their deteriorating fundamentals or performance. Similarly, this study's identification of bubbles can aid the regulators to enhance the operation of the business cycle. Since multiple bubbles also exist in the Pakistan stock exchange, regulators should take preventive measures by using an advanced (GSADF) test that can accurately detect multiple bubbles because whenever prices deviate more from their fundamental values, there is always a financial crunch when bubbles burst. Furthermore, policymakers should consider improving the transparency of investor information, which would reduce uncertainty about the economic environment and strengthen the market by reducing misleading stock price movements.

5.2 Limitations

Hence, these results can help to understand only the evolution of past bubbles which may be considered one of the major limitations of this study through which various upcoming financial crises can be avoided by regulators rather than predicting the financial bubbles. Second, the unavailability of most listed companies' price and dividend data was a major issue, so the time period for the analysis was set to begin in 2000 because 80% of the data was only available since that year. Lastly, continuous data of price-to-dividend variable is used to investigate mild explosive behavior (that is not always available when it comes to individual stocks) along with its exact origination and termination dates through BSADF statistics.

5.3 Future area of research

For the future area of research, other innovative techniques like artificial neural networks or fuzzy neural networks can be employed to predict future bubbles which can help regulators and financial investors mitigate their losses. Moreover, if any economy lacks data regarding the dividend variable, book-to-market ratio can be used to test the existence of a speculative rational bubble (Caspi, 2017).

Data Availability Statement
Data can be available based on the request at asra.shaikh@szabist.edu.pk

Acknowledgments
The authors would like to thank anonymous reviewers and the editor.

Conflicts of Interest
The authors declare no conflict of interest.

Notes

1. Data availability – Monthly data of 'Price per share' and 'Dividend per share has been taken from Refinitiv Eikon data stream of companies listed in Pakistan and emerging markets (MSCI index) for the computation of the Price to Dividend ratio.
2. Pakistan is considered for the analysis besides the eight emerging markets (MSCI index) because Pakistan was reclassified as a frontier market just recently in September 2021 but shares the major characteristics of emerging markets.
3. Software - E-views -10 software is used for testing various right-tailed tests, this may take a while since it involves Monte Carlo simulations with 1000 replications.
4. Indian Stock market: Regarding this market, analysis has been performed in both the Bombay stock exchange (BSE) and Nifty (50) index to cross-check the results. Our findings suggest bubbles are insignificant in both BSE and Nifty stock markets.
5. Rationale for using Price to Dividend Ratio: Some researchers also use prices to detect the bubbles but this may cause biases in the results. If the dividends are set aside by considering only the investment of a firm and also ignoring all the income factors, then this may create biases in the results. For example: if a firm's stock price increases accompanied by an increase in dividends then this shows there is performance support in a firm. Thus, one cannot conclude a bubble from the price (Li, Xiao, Yang, Guo, and Yang, 2021). Therefore, this study has considered the Price to Dividend ratio for analysis purpose.
6. Monte Carlo simulation: This method is commonly used in statistical modeling or analysis to estimate p-values without relying on asymptotic distribution theory or complicated /exhaustive enumerations.

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