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Identification of multiple stock bubbles in an emerging market: application of GSADF approach

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Abstract This paper aims at to investigate the existence of multiple bubbles and specific corresponding events in Pakistan Stock Exchange across different industrial sectors using Generalized Sup Augmented Dickey Fuller (GSADF) test of right-tailed ADF as proposed by Philips et al. (Int Econ Rev 56:1043–1078, 2015a, Int Econ Rev 56:1079–1134, 2015b) by using monthly data for the period of 2007–2016. Findings of study confirm the existence of multiple bubbles in KSE-100 Index along with different industrial sectors. Empirical results depict that Investments, Chemicals and Textile Spinning were the only few sectors where no stock price bubbles were identified. The present study is expected to be pioneer in its nature to apply GSADF for the identification of multiple stock bubbles in emerging stock market of Pakistan which can be further used for comparison of stock bubbles in other regional markets such as BRICS or SAARC regions in order to find out the similarities and dissimilarities in the events causing stock market bubbles.

Keywords Multiple bubbles · GSADF · KSE-100 index · Emerging market · Pakistan

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1 Introduction

Theory of behavioral finance describes stock market bubbles as cognitive biases resulting from investing phenomena of "emotional investing" that causes security prices to go beyond rational reflection. The asset price bubble or speculative bubble is often used to define persistent market overvaluation followed by the market collapse (Reza 2010). These price spikes are formed by a stream at stock prices irrespective of fundamentals of the asset valuation and heavily influenced by strong and highly active market trend (Joarder et al. 2014). Recent literature reveals a significant amount of research highlighting that stocks are highly unpredictable and are driven by market factors. The existence of bubbles in stock market have some implicative consequences on an economy. Bubbles may affect an economy positively as well as negatively as these create temporary strong deviation from price trends (Jiménez 2011). However, there are empirical studies suggesting that every episode of bubble creates wealth redistribution in the economy and can retard economic growth (Tirole 1985; Jiménez 2011). Bubbles can also create economic misrepresentation as real economy and financial variability, and have effects on output progress, collective expenditure and anticipated inflation (Roubini 2006). Consistent with this, Misati and Nyamongo (2012) argue that monetary policy cannot overlook the information from the stock market because this information can be used to forecast the direction of the business cycle.

The identification of stock bubbles and their respective period is important for capital market regulators, financial economists and investors from many aspects. For instance, global financial crises was originated from a real estate price bubble. Earlier, Dot-Com bubble had significant impact on employment, economic growth and overall health of the financial system (Bhanja and Dar 2015). The timely identification of bubble period may assist policy maker and investors with the opportunity to mitigate their losses of investment and damage to the economy, particularly in the emerging economies where financial system in not much resilient to the undesired gigantic variations in the stock prices. For policy making and global portfolio divergence purpose, stock market bubble identification is of significant nature as Chan et al. (2003) explicated that regulators need to control market fundamental factors only while executing monitory policy if stock bubbles do not exist in equity markets. Otherwise, monetary policy needs positive actions to control expectation from the bubble pathway as well.

Existing literature reveals various statistical techniques in order to identify the existence of such stock market bubbles and to overcome the shortcomings of traditional empirical bubble tests such as cointegration tests and unit root tests, a recursive method of Supremum Augmented Dickey Fuller (SADF) was introduced by Phillips et al. (2011), that may observe exaggerations in stock prices during a period. However, Phillips et al. (2011) recursive method of SADF is exclusively useful when there is only one bubble in the sample data. However, there is a possibility that the multiple bubbles may exist in stock markets in a given time frame. Hence, Phillips et al. (2015a, b) developed a more sophisticated technique to identify multiple bubbles in stock market namely Generalized Sup

Augmented Dickey–Fuller (GSADF) test. The key feature of using this advanced technique is that one can account for nonlinear structure and structural break mechanism while identifying presence of bubbles in a stock market.

The Pakistan stock Exchange (PSX) is the capital market of Pakistan with trading floors in Karachi, Islamabad and Lahore and dealing in equities, debt and derivative securities among others. Morgan Stanley Capital International (MSCI) also reclassified PSX as an emerging market (Dawn 2017), while Financial Times Stock Exchange (FTSE) classified PSX as a secondary emerging market (Dawn 2008). PSX was established after integration and demutualization of individual stock exchanges of Karachi, Islamabad and Lahore in January 2016. The integration and openness of three stock exchanges is assumed to have positive effects on the growth and development of the economy as it encouraged participation in capital market investment across the country as well as foreign portfolio investment which leads towards economic growth via intellectual property, technology transfer and innovation, as indicated by earlier researchers (Greenhalgh 2016; Iwasaki and Suganuma 2015; Liu and Nishijima 2013). Historically, Pakistan has transformed its economic system more to be more liberalized and open for foreign investment (Bahmani-Oskooee et al. 2017). In this context, other than expanding the investor access and participation, the capital market integration enhanced operational and informational efficiency of the market. KSE was among the world's best performing stock markets during 2009–2015 as Pakistani equities delivered 26% yearly return for foreign investors since 2009 (The Express Tribune 2015a, b, c). Figure 1 below presents the trend in KSE-100 index over the last decade where it showed tremendous growth and increased approximately by 500% since 2007 till 2016.

Moreover, the economy of Pakistan expanded by a rate of 4.71% in 2016 as compared to previous year, whereas the average annual growth rate of Pakistan economy from 1952 to 2016 sustained at 4.91% and since 2005, the economy is growing at an average of 5% a year (The Express Tribune 2015b). While current economic situation of Pakistan suggests that economic growth will continue, it may be argued that increase in monthly returns of stock price index were an indicator of persistent variations in stock prices from market fundamental that needed to be investigated using more sophisticated bubble identification techniques such as GSADF.

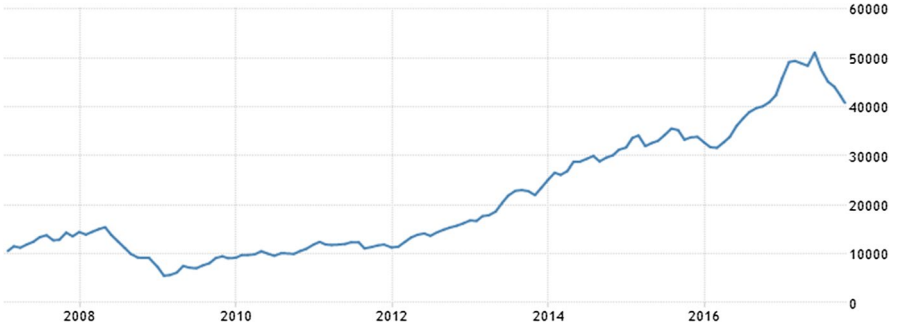

Fig. 1 Pakistan stock exchange 100 index (KSE100). *Source* www.tradingeconomics.com

The present study is an attempt to apply GSADF test to identify the presence of multiple bubbles in Pakistani stock market using KSE-100 index along with various industrial sectors data for the period of 2007 to 2016. We intend to investigate whether the drastic increase in stock market index and market performance during this decade is showing a bubble occurrence or true performance based on stock market fundamentals. Being an emerging capital market of the region, identification of multiple stock bubbles in case of Pakistan is a significant research issue as highlighted by Kasman et al. (2009) that emerging stock markets face higher volatility than developed stock markets and these markets frequently face regular and unpredictable variations which mostly attributed by local events than global ones.

2 Literature review

Extensive work has been done on the existence of multiple stock bubbles both in developed and emerging economies. In the context of bubble identification in stock markets, Schnabl and Hoffmann (2008) investigated monetary policy, vagabonding liquidity and bursting bubbles in emerging markets and showed that subprime market crises disturbed world financial system by using (monetary point of view) overinvestment theories of Schumpeter (1983), Wicksell (2005) and Hayek (1976). They suggested that significant interest cuts in response of financial crises in subprime market stopped major breakdown during the 1980–2007. Moreover, Li and Xue (2009) used Bayesian's bubble and identified a Bayesian investor presumption when facing probable structural interruption in the economy by using Pástor and Veronesi (2006) model and showed such presumptions played vital role in boom and crash in stock market during 1998–2001.

In addition, Bhattacharya et al. (2010) worked on the relevance of accounting information in a stock market bubble and found that internet IPO firms disclosed fewer accounting details and most of the investors undervalued the early cautionary signals. Brunnermeier and Nagel (2004) worked on hedge funds and confirm the well-organized market belief that rational speculator always stabilizes prices and analyzes hedge funds by using clinical study of trading during bubble episodes rather than conventional test theories. From an emerging market perspective, Yao and Luo (2009) investigated into the economic psychology of stock market bubble in China and found that bubble was started due to greediness, bitterness and rumor, lack of cash, over valuation and weakness of listed companies stock bring stock market crash in 2008. They used non-economic explanation (investment psychology of investors) to explain the boom and bust during 2006 to 2008 which can be considered China's most significant event of wealth redistribution making rich richer and poor poorer in China. Similarly, Yu and Kabir Hassan (2010) observed rational speculative bubbles in eight MENA region capital markets including Bahrain (1996 to 3003), Israel (1997 to 2003), Oman (1999 to 2003), Saudi-Arab (1998 to 2003), Morocco (1996 to 2003), Jordan (1997 to 2003), Egypt (1996 to 2003) and Turkey (1987 to 2003) by using fractional integration techniques, duration dependence test based on ARFIMA (Autoregressive Fractionally Integrated Moving Average) model

and non-parametric Nelson-Aalen smoothed hazard functions. Their study reported no strong corroboration of speculative bubbles in MENA region.

Nartea and Cheema (2014) showed bubbles footprints in Malaysian stock market by examining the existence of bubbles for relatively a longer time period of 1988–2013 that also includes 2 unproven bubble periods—Asian financial crises of 1997 and global financial crises of 2007–2008 using explosiveness tests and duration dependence test. Anderson and Brooks (2014) investigated speculative bubbles and cross-sectional variation in stock returns by developing an empirical asset pricing model and showed that stocks combined with larger bubble produce higher returns. Moreover, they also confirmed that discrepancy in stock returns can be due to the price bubbles and not due to fundamental drivers during the period of 1980–2012. Additionally, Asako and Liu (2013) applied a statistical model of speculative bubbles identification to the stock markets of the US, China and Japan. They argued that this model can recognize how and when a new bubble is generated and eliminated.

Furthermore, Wang and Wong (2015) investigated rational speculative bubbles in the US stock market and political cycle by using duration dependence test for the period of 1927–2012 and found that there were more rational bubbles in republican presidency era. Chang et al. (2016) presented evidence of the existence of stock market bubbles in BRICS (Brazil, Russia, India, China and South Africa) and found that bubbles were strong in Brazil, Russia, and South Africa and multiple bubbles have different strength by using newly developed GSADF test using data for the period of 1990 to 2013. Almudhaf, (2017) worked on speculative bubbles identification and irrational exuberance in African stock markets and found strong evidence of multiple speculative bubbles in Botswana, Egypt, Ghana, Kenya, Nigeria and Tunisia by using SADF test and sequential unit root of Phillips test. In China, Li (2015) identified critical dates of the Chinese stock market bubbles (i.e. July 2006 to Oct 2007, Dec 2007 to Oct 2008, Oct 2014 to June 2015) by using Log Periodic Power Law Singularity (LPPLS) model. Similarly, Mcaleer et al. (2016) worked on Dot-com bubble, subprime crises and Asian financial crises. They developed bubble exposure signal which investor/regulator can use for stock trading. Later on, Balcilar et al. (2016) investigated the presence of periodically collapsing bubbles in the South African stock market and concluded that greater stock returns volatility in relation to market fundamentals can be associated with creation of bubbles by using GSADF test for a period 1954–2015.

Later on, Pavlidis et al. (2016) employed recursive unit root tests developed by Philips et al. (2015a) for detection of occurrences of explosive dynamics in the housing sector of several countries. Based on the dataset related to commonly used indicators of housing market (price-to-rent ratios, price-to-income ratios, and real house ratios), the authors also proposed an innovative extension in the test established by Philips et al. (2015a) for exploiting the larger cross sectional aspects of panel dataset. The study found certain periods of exuberance in the housing markets of many countries which were statistically significant. Moreover, the findings also suggested that global economic conditions, credit growth and long-term interest rates are some of the main macro-economic prognosticators of housing market bubbles in the sample countries. From another perspective, Pavlidis et al. (2017) employed rolling Fama regressions and recursive unit root tests developed by Philips et al. (2015a) to detect bubbles in

derivative currency market. Evidence of bubbles has been found during interwar Germany hyperinflation for application of US dollar exchange rates, however, no such evidence was found for recent floating exchange rate regime.

Recently, Escobari et al. (2017) investigated the identification of stock bubbles in Latin American capital markets by using Philips–Perron-based tests for a period of 2000–2014 and showed strong link between bubbles episodes across stock markets of Latin America by using GSADF developed by Phillips et al. (2015a). Moreover, Creti and Joëts (2017) also researched on multiple bubbles identification in European Union emission trading scheme by using GSADF test during 2005–2014 and found multiple episodes of bubbles. They concluded that these bubbles occurrence are not described by similar performance of the fundamentals but seems to be associated with energy and environmental policy declarations. Recently, Dar and Bhanja (2018) also identified turbulent periods in Chinese stock market in comparison to other regional capital markets of Taiwan, Singapore and South Korea using wavelet power spectra of stock returns.

Stock prices in Pakistan has been relatively explosive since 2007 and it recently has hit very low values as well. However, as per authors' best knowledge, no empirical study exists to evaluate whether unpredictability and price rising tendency are due to price bubbles and multiple events of speculations. The proposed study fills this research gap. In econometrics, various methods can identify the existence of price bubbles with many complications (i.e. Diba and Grossman 1988; Evans 1991). These methods allow testing by using standard left-tailed Dickey Fuller Test unit root test. On the other hand, alternative approaches such as Markov switching unit root test and cointegration test are not capable to spot multiple bubbles in stock prices. Hence, to overcome these complexities, Phillips et al. 2015a, b) suggested use of GSADF to detect date-stamped and mildly explosive behavior and market exuberance. They suggested to use right-tailed ADF test keeping in view that there can be more than one episodes of bubbles in a single sample period. Given the sophistication of GSADF test, the present study also uses this approach in identifying the multiple stock price bubbles for Pakistan Stock Exchange (PSX) for the period of 2007 to 2016.

3 Research design and methodology

Based on Campbell et al. (1997), Cuñado et al. (2005), and Koustas and Serletis (2005), our model comprises net stock returns explained as follows:

$$\mathrm{SR}_{t+1} = \frac{P_{t+1} - P_t + D_{t+1}}{P_t} = \frac{P_{t+1} + D_{t+1}}{P_t} - 1 \tag{1}$$

Here SR_{t+1} means the stock return in time $t+1$ and D_{t+1} means dividend in period $t+1$. By arithmetical anticipation on Eq. (1) on the basis of data obtainable at that time t, and reordering terms, we may get this form:

$$\mathrm{P}_t = \mathrm{E}_t\left[\frac{P_{t+1} + D_{t+1}}{1 + SR_{t+1}}\right] \tag{2}$$

We may solve Eq. (2) for k periods and get the subsequent semi summarized procedure as:

$$\mathrm{P_t} = \mathrm{E_t}\left[\sum_{i+1}^{k}\left(\frac{1}{1+SR_{t+1}}\right)^{i} D_{t+1}\right] + \mathrm{E_t}\left[\left(\frac{1}{1+SR_{t+k}}\right)^{k} P_{t+k}\right] \tag{3}$$

To get an exclusive result in Eq. (3), we suppose that the anticipated discounted stock value in the unlimited upcoming analysis to 0:

$$\lim_{k\to\infty} E_t\left[\left(\frac{1}{1+SR_{t+1}}\right)^{k} P_{t+k}\right] = 0 \tag{4}$$

On the basis of convergence statement, we can obtain the stock's fundamental value as the anticipated present value of future dividends as:

$$\mathrm{F_t} = \mathrm{E_t}\left[\sum_{i=1}^{\infty}\left(\frac{1}{1+SR_{t+i}}\right)^{i} D_{t+i}\right] \tag{5}$$

If we obtain from the convergence statement, then Eq. (4) may show different results and from these results, one can be write down in the subsequent method:

$$\mathrm{P_t} = \mathrm{F_t} + \mathrm{B_t} \quad \text{where} \quad \mathrm{B_t} = \mathrm{E_t}\left[\frac{B_{t+1}}{1+SR_{t+1}}\right] \tag{6}$$

here the added term $\mathrm{B_t}$ is known as a rational bubble in the observation which is unconditionally stable with balanced expectation and the period of projected returns. Diba and Grossman (1988) also defined a rational bubble means variation in stock prices from their fundamental value can be led by useless variable. If this non-stationarity in dividends accounts for the non-stationarity of stock prices, then there is cointegration in dividends and stock prices. Cointegration in dividends and share prices can examine the hypothesis of no bubbles. A cointegration relationship in stock prices and dividends is disinclined with rational bubbles. Comprehensibly, stationarity in dividend price ratio will be consider the very same.

In empirical literature, detecting the bubble has practically been a big challenge. Econometric techniques suffer from limited selected sample bias such as predictable unit root and cointegration tests can only detect single episode of bubble but cannot find out infrequently collapsing bubbles. Like for detection of warning sign of future stock market bubble delayed due to requirement of marking to initial and ending period. The main reason is because normal unit root tests cannot manage variations from $I(0)$ to $I(1)$ and again back to $I(0)$. This made finding by cointegration techniques tougher because of bias and kurtosis (Evans 1991).

Recently, Phillips and Yu (2011) and Phillips et al. (2011) has developed an advanced approach for identifying multiple bubbles in a more sophisticated

econometric way. The approach identifies bubbles not only when they arise but also after when it has been distorted. Their opinion was that volatile behavior of bubble is different than the walking behavior. Likewise, they have established a recursive econometric procedure for understanding slightly volatile unit roots as a clue for bubbles. Focusing on the distinctive variance of stationary and trend stationary testing method for a unit root test, we most of the time limit our emphasis to areas of "no more than" a unit root procedure, i.e., an autoregressive procedure where $\delta \leq 1$. In distinction, Phillips and Yu (2011) model has slightly greater performance by an autoregressive procedure with a unit root δ that increase unity but still in a region of unity. The main idea behind this test is to analyze recursively right sided ADF unit root to calculate indications for mildly explosive performance in the information available. The test is a right-tailed which is different from the normal left-tailed test for stationarity. Especially, by considering the subsequent autoregressive description assessed through recursive least square, we can write:

$$x_t = \mu + \delta x_{t-1} + \sum_{j=1}^{J} \emptyset_j \Delta x_{t-j} + \varepsilon_{t.} \tag{7}$$

The common H_o: $\delta = 1$ applies, but contrasting the left sided tests that have implication for a static alternate, Phillips and Yu (2011) have H_a: $\delta > 1$, which, with $\delta = 1 + c/k_n$ where $c > 0$, $k_n \to \infty$ and $k_n/n \to 0$, and this permit for their slightly explosive cases.

According to Phillips and Yu (2011), this test has unmatchable power as it can handle the changes which occur from unit root test to mildly volatile test or vice versa during the ongoing process. The sensitivity of right sided test is also greater than the left sided unit root tests against static changes. But as we know, bubble normally arise and burst periodically. So, normal unit root tests cannot identify the periodically fading bubbles. To handle this problem, Phillips and Yu (2011) recommended to use supremum of recursively determined Augmented Dickey–Fuller (ADF) *t*-statistics. This method can find periods where bubble arise in price of stock procedure. This test can be used chronologically on different samples. The starting period of bubble is assessed when ADF *t*-statistics is higher than its conforming critical value of right tailed ADF. There will be ending of bubble if ADF *t*-statistics is not higher than the corresponding critical value.

By using Phillips et al. (2011) we may estimate a classification of ADF. Let $\hat{\delta}_y$ signify the OLS estimator of δ and $\hat{\sigma}_{\delta,y}$, the normal estimator for standard deviation of $\hat{\delta}_y$ using the subsample $\{x_1, x_{2\ldots}x^t_{[y]}$ signifying the fractional window size set by the researcher and presumptuous is simplicity for sample, a sample interval of (0,1). The SADF test depends on repeated estimation of the ADF and the test is obtained as the sup value of the corresponding ADF statistic sequence. The window size, r_w, increases from r_0 to r_1; so that r_0 is the smallest window size fraction and r_1 is largest window fraction (the total sample size) in the recursion. The starting point r_1 of a sample sequence is fixed at 0; so, the end point of each sample (r_2) equals r_w and changes from r_0 to r_1. The ADF statistics for a sample that runs from 0 to 2 is denoted by $ADF_0^{r_2}$. The forward recursive ADF test of H_0 against H_a is given by:

$$\mathrm{SADF}(\mathrm{r}_0) = \sup_{r_2 \varepsilon [r_0,1]} \left\{ ADF_0^{r_2} \right\} \tag{8}$$

where $\mathrm{ADF} = \hat{\delta}_t - 1/\hat{\sigma}_{st}$. Here the ADF measurement is calculated for irregular interval (r_0, r_1). In most of the times, our r_0 will be set to start with a sample fraction of reasonable size. But, one constraint of SADF test is that the starting point is fixed as the first reflection of the selected sample. For instance, if there are two bubbles in any economy or sector, the second bubble will be dominated by first identified bubble. So, Phillips et al. (2011) also use SADF rolling version test, where the initial window changes across the sample. So, starting window size is still fixed that restricts the test power.

Phillips et al. (2015a, b) recommended to use the SADF test as a dating tool. The ADF analytic is based on sequential right-sided ADF tests, but the analytical sample arrangement to more versatile in range (Nusair 2012). They proposed generalized SADF test that changes the initial and ending points of a sample across a reasonable series of windows instead of fixing the starting point of the sample. In other words, we can use more subsamples in the recursion in the GSADF test because it can cover a larger number of subsamples than SADF test. Moreover, GSADF test not only allows to change starting point r_1 during a reasonable period from 0 to $\mathrm{r}_2\_\mathrm{r}_0$ but can also varies the ending points of regression r_2 from r_0 (the minimum window width) to 1. The test is consistent with multiple boom-bust episodes during a given period (Pavlidis et al. 2016). The GSADF test is well defined as largest ADF statistics during all possible ranges of r_1 and r_2. The test statistics is denoted by GSADF(r_0):

$$\mathrm{GSADF}(r0) = \sup_{r_2 \varepsilon [r_0,1], r_1 \varepsilon [r_2 - r_1]} \left\{ ADF_{\mathrm{r1}}^{r_2} \right\}. \tag{9}$$

Phillips et al. (2015a, b) reported that the GSADF moving sample test can investigative SADF test with the increasing sample size in exploring volatile performance in various bubble events and hardly give wrong results, even in comparatively uncertain samples as the GSADF test handles more data samples and has much flexibility in window. The GSADF can detect several bubbles in a given sample and, hence covers the SADF limitation.

Like SADF test, null hypothesis is rejected in GSADF test at the initial and ending point of a bubble. The starting point of bubble is showed as T_{re}, defined as date when BSADF sequences is more than the critical value from below. Similarly, the ending point defined as the date T_{fe}, where BSADF arrangement crosses the critical value from above. Formally, the estimations of the bubble periods based on GSADF test are defined as:

$$\hat{r}_e = \inf_{r_2 \varepsilon [r_0,1]} \left\{ r_2 : BSADF_{r2}(r_0) > cv_{\mathrm{r2}}^{\beta_t} \right\} \tag{10}$$

$$\hat{r}_{\mathrm{f}} = \inf_{r_2 \varepsilon [\hat{r}\mathrm{e},1]} \left\{ r_2 : BSADF_{r2}(r_0) < cv_{\mathrm{r2}}^{\beta_t} \right\}. \tag{11}$$

where $cv_{r2}^{\beta_t}$ is the $100(1-\beta_t)\%$ critical value of the SADF statistic based on (T_{r2}) observation. The BSADF(r_0) for $r_2 \epsilon(r_0,1)$, is the backward SADF statistic that relates to the GSADF statistic by noting that:

$$\underset{r_2\epsilon[r_0,1]}{\text{GSADF}}(r_0) = \sup\left\{BSADF(r_0)\right\} \tag{12}$$

To examine the multiple bubbles in PSX index and different industrial sectors, the present study uses secondary data of monthly closing price KSE-100 index and 24 industrial sectors, adjusted for market fundamentals (i.e. dividends) in Pakistan stock exchange (PSX) from 2007–2016. The data has been obtained from the official website of the Pakistan Stock Exchange.

4 Results and discussion

Table 1 reports the empirical results of GSADF test whereas Fig. 2 graphical portrays bubble episodes with date-stamped period when the bubbles occurred. As discussed earlier, the present study used the GSADF test from right-tail ADF because it can handle more subsamples of the data. Based on the results given in Table 1 and Fig. 2, overall KSE-100 index behaved normally during the sample period of 2007–2016. However, as depicted in Fig. 2, there exist a stock price bubble in Pakistan Stock Exchange in the mid of year 2008. This bubble is attributes towards the temporary suspension of trading in the stock market for few months. As per the findings of Shamim Ahmad Khan's Committee Report, the then chairman SECP attempted to impose trading floor in the stock market with the help of some stock market brokers who had "commercial motives" causing suspension of trading in the market for 110 days, termed as "gravest mistake". This crash in the stock market tormented many small investors financially and market capitalization was deteriorated approximately by Rs. 1.3 trillion (The Express Tribune Report 2015a, b, c).

Moreover, Table 2 reports the empirical results of GSADF test across the different industrial sectors of Pakistan Stock Exchange whereas Figs. 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25 and 26 depict

Table 1 The GSADF test-pakistan stock exchange

Test	*t*-statistic	Prob.*
GSADF test statistic for KSE-100 Index	2.925906	0.0028
Test critical values**:		
99% level	2.585514	
95% level	1.999745	
90% level	1.700759	

*Right-tailed test

**Critical values are based on a Monte Carlo simulation (2007: January–2015: December)

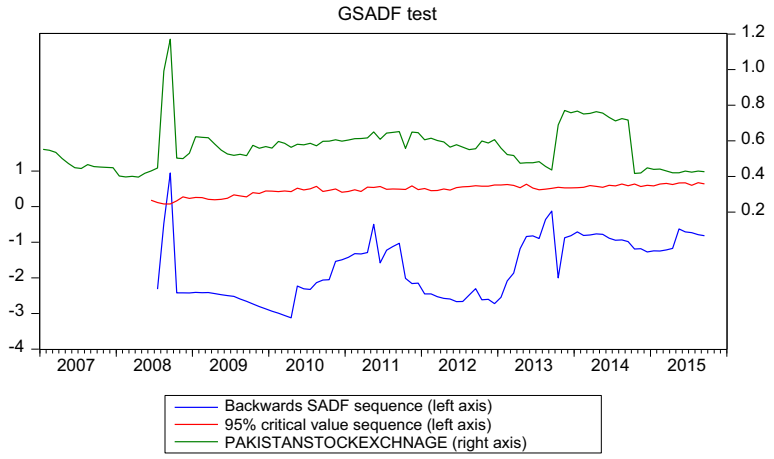

Fig. 2 Date-stamp bubble period in Pakistan stock exchange

Table 2 The GSADF test-sectorial analysis

Sr. no.	Industrial sectors	*t*-statistic	Prob.*
1	Cable and electrical goods	2.993663	0.0030
2	Investments	0.343321	0.7820
3	Chemicals	0.235997	0.8560
4	Pharmaceuticals	0.567716	0.6560
5	Textiles spinning	0.236393	0.9730
6	Modarabas	1.440013	0.1800
7	Oil and gas exploration	2.170496	0.040
8	Automobile assemblers	3.130145	0.0000
9	Automobile parts	1.698731	0.0270
10	Cement and construction materials	1.367409	0.2130
11	Tobacco	1.589353	0.1380
12	Food producers	5.342260	0.0000
13	Power generation	1.262354	0.2500
14	Paper and board	4.072813	0.0000
15	Textile composite	2.367848	0.0203
16	Transportation and communication	2.547437	0.0000
17	Sugar and allied industries	1.237760	0.2623
18	Leather	4.286662	0.0000
19	Synthetic and ryan	3.5427	0.0000
20	Close-ended mutual funds	1.8047	0.0750
21	Insurance	0.806972	0.5140
22	Commercial banks	3.740153	0.0001
23	Fertilizers	1.665433	0.0910
24	Oil and gas marketing	5.830495	0.0000

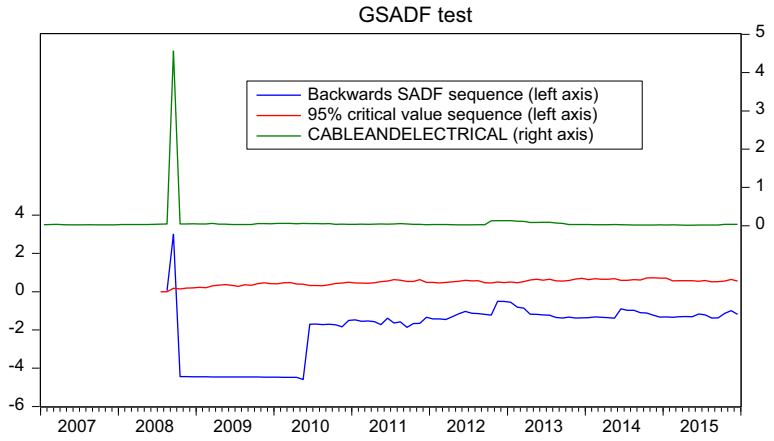

Fig. 3 Cable and electrical goods

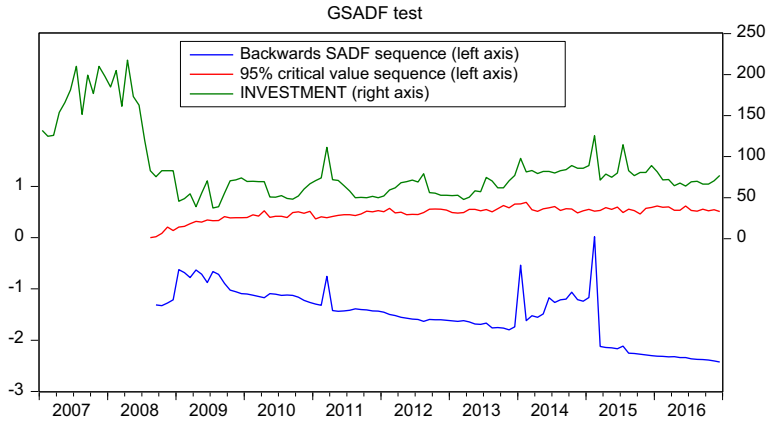

Fig. 4 Investments

the graphical representation of date-stamped bubble periods. These figures are showing evidence of bubble periods various industrial sectors of Pakistan Stock Exchange. For instance, except investments, chemicals and textile spinning sectors, almost all the industrial sectors faced some stock price bubbles during the sample period. Among these multiple bubbles, the most common asset pricing bubble was of 2008 which was the stock market crash of 2008 where the capital market trading was suspended for more than 3 months. The sectors facing 2008 bubble include Cable and Electric Goods, Pharmaceuticals, Modarabas, Oil and Gas Exploration, Automobiles Assemblers and Parts, Cement and Construction Materials, Tobacco, Food Producers, Power Generation, Textile Composite, Close-ended Mutual Funds, Commercial Banks, Fertilizers, and Oil and Gas Marketing (Figs. 3, 6, 8, 9, 10, 11, 12, 13, 14, 15, 17, 22, 24, 25 and 26). Most

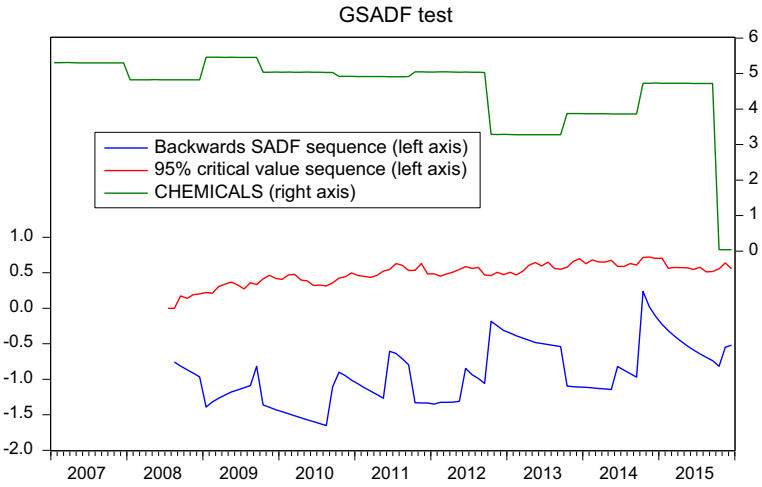

Fig. 5 Chemicals

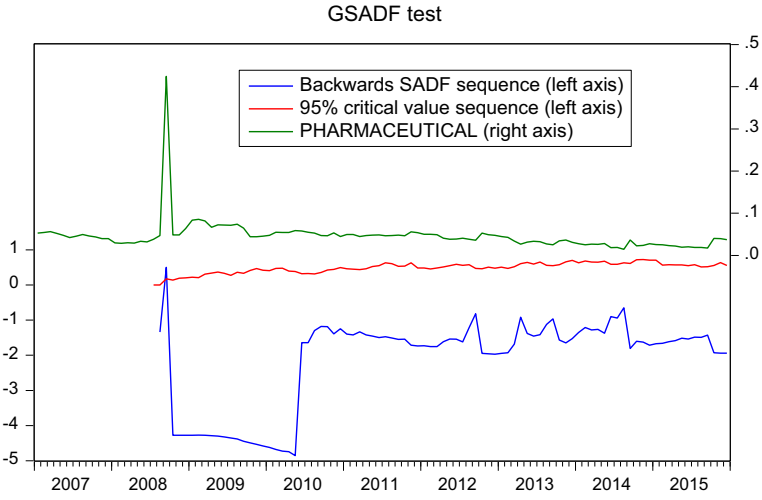

Fig. 6 Pharmaceuticals

of these sectors including actively trading companies which were influenced by the temporary suspension of stock market trading in 2008. The KSE 100 index touched its peak of 15,600 points in April 2008, before it started to fall. Protests followed as the stock exchange saw interesting tendency with economic adversities, political uncertainty and global financial crises took their toll in index that was categorized by both investors overconfidence and declining KSE to 9144 points with further decline expectations. Moreover, commercial banking and close-ended mutual funds (Figs. 22, 24) also sustained bubble in early

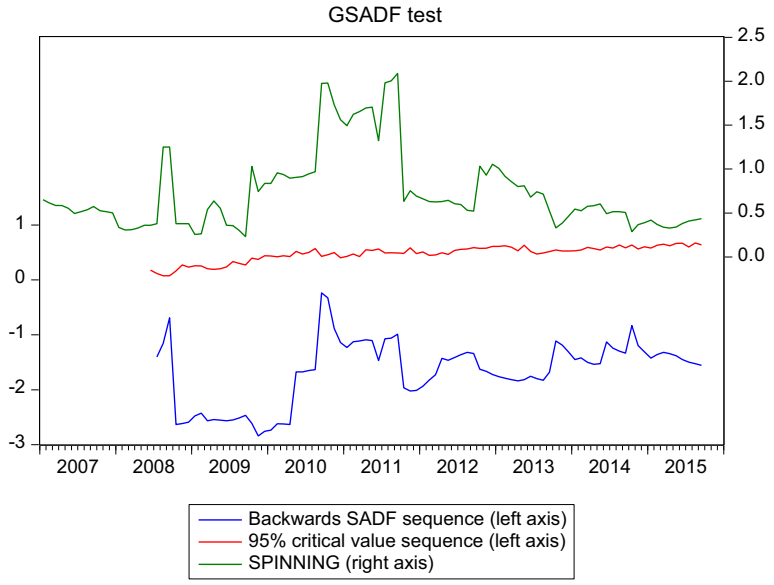

Fig. 7 Textile spinning

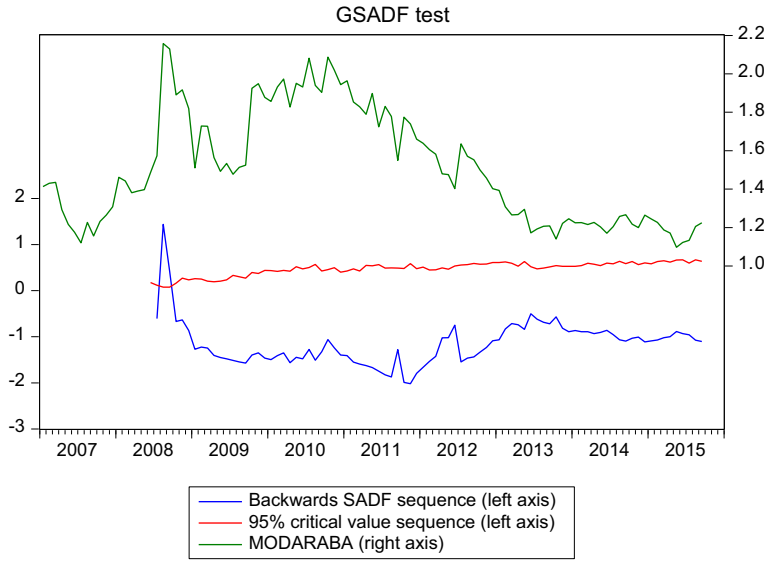

Fig. 8 Modarabas

months of 2014. In the first month of 2014, this trend may be attributed to the market expectations of that State Bank of Pakistan maintaining discount rate at 10%, healthy foreign investors activity, upward global growth forecast, improved investors' confidence because of government deliberations with Taliban, reduced

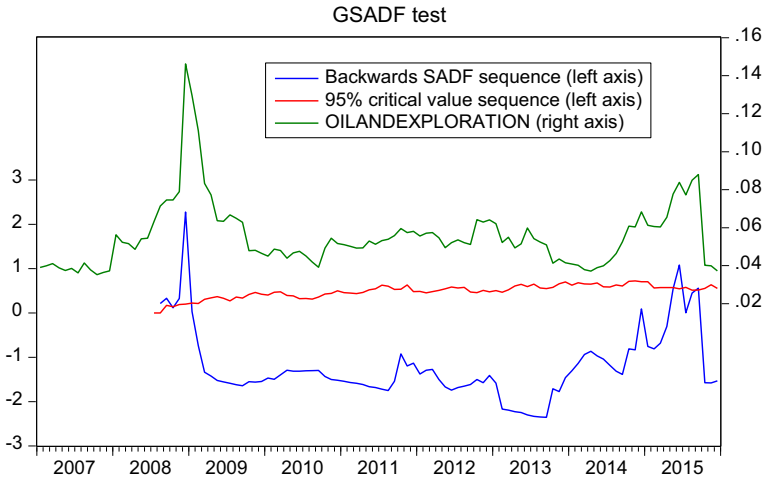

Fig. 9 Oil and gas exploration

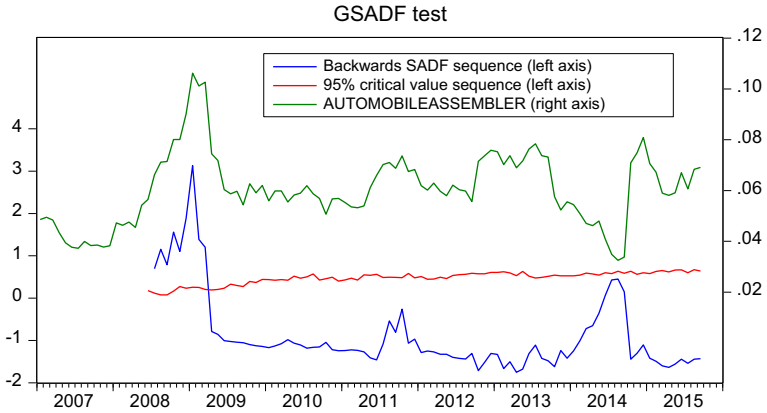

Fig. 10 Automobile assemblers

Net International Reserve (NIR) requirements for Pakistan by US$ 2 billion and extended fund facility by IMF (NAFA Fund Manager Report 2017).

Figures 20 and 21 shows footprints of bubbles existence in Synthetic and Ryan and Leather sectors. This bubble of August 2012 bubbles may be ascribed to State Bank of Pakistan monetary policy decision to cut the discount rate by 50 basis points and a healthy foreign investors activity. Moreover, bubble of 2013 in Leather and Fertilizers sectors (Figs. 20, 25) is due to general elections conducted in Pakistan, positive expectation related to transition of power from one democratic government to another one which is the first time in the history of Pakistan, downward trends in inflation, and positive inflows of foreign portfolio investment in the capital market.

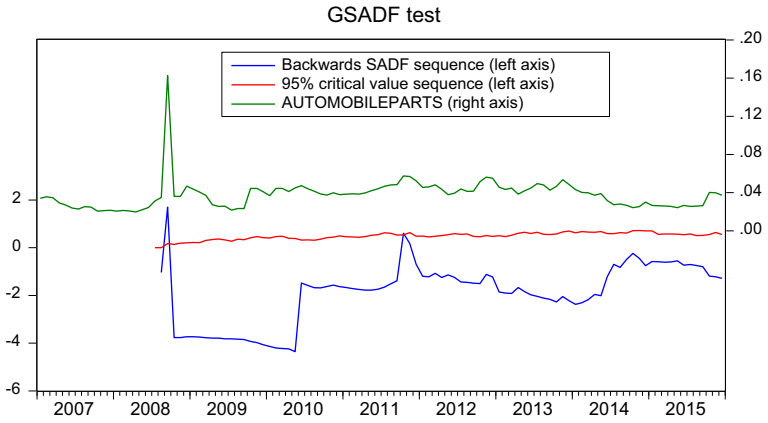

Fig. 11 Automobile parts

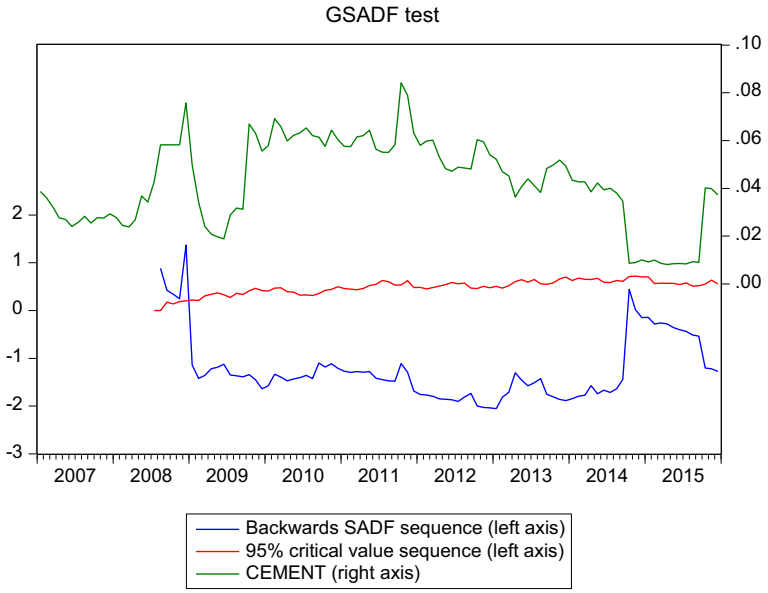

Fig. 12 Cement and construction materials

Moreover, textile exports were also increased in the month of December 2013 by 25%, which lead the upward trend in market value of whole textile sector.

Furthermore, 2014 was considered as a year of growth for Pakistan Stock Exchange. Figure 16 (Paper and Board sector) is showing multiple bubbles in 2014, 2015 and 2106 which is very strong stock price bubble. This might be due to the political stability in country as Chairmen of Pakistan Tehreek-i-Insaaf, called off the party street sit-in protest following terrorist attack in a school of

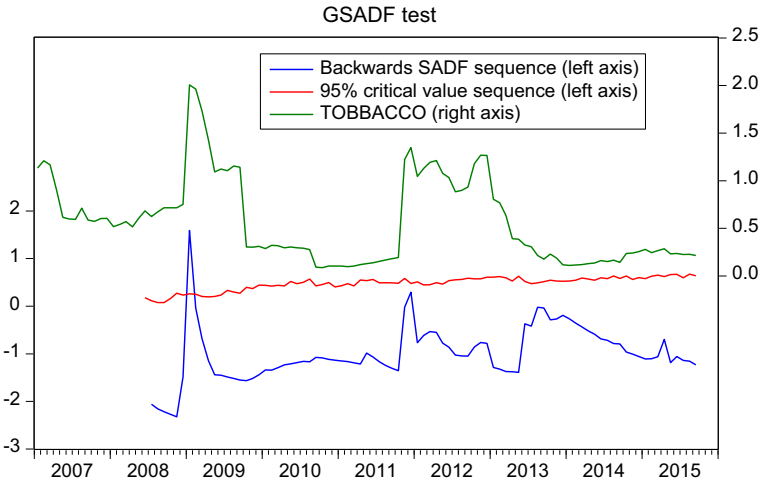

Fig. 13 Tobacco

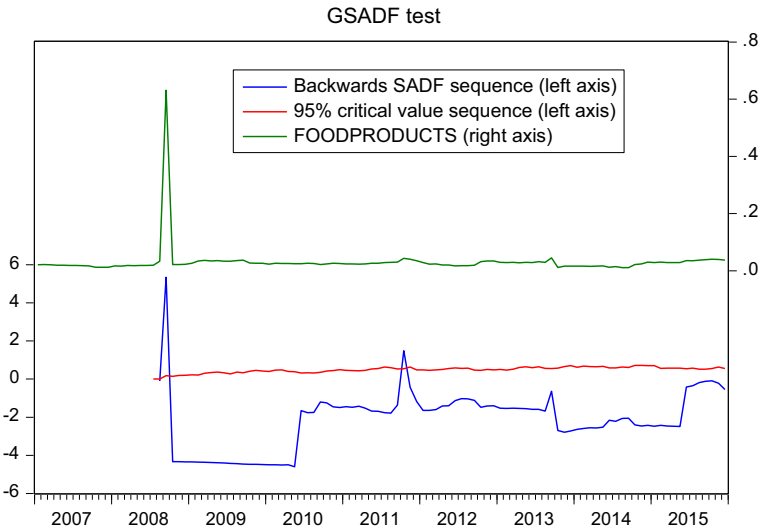

Fig. 14 Food producers

Peshawar in December 2014. Moreover, this bubble might be due to downward trends in inflation and interest rates, economic stability in country, Pakistan and China enter second round of Free Trade Agreement (FTA), and willingness of Saudi Arabia to supply crude oil to Pakistan at a subsidize rate (NAFA Fund Manager Report 2017). Finally, null hypothesis of no bubble cannot be rejected in case of industrial sectors of Investments, Chemicals, and Textile Spinning sectors

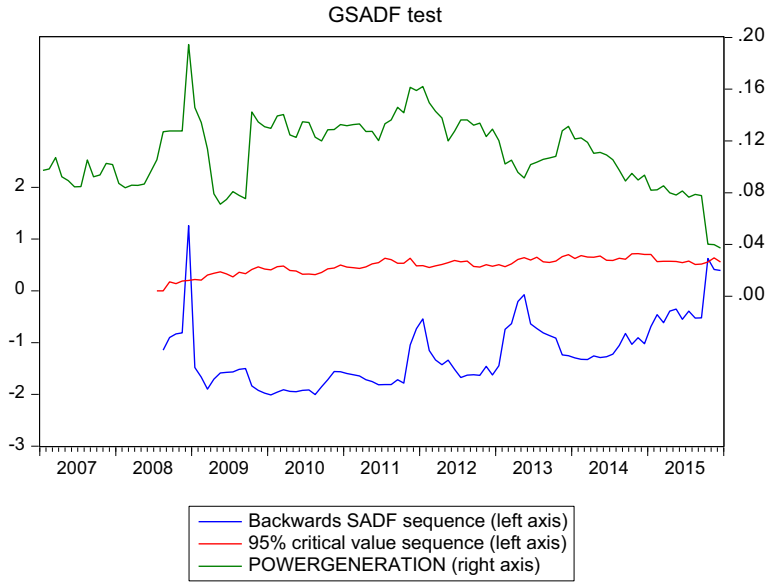

Fig. 15 Power generation

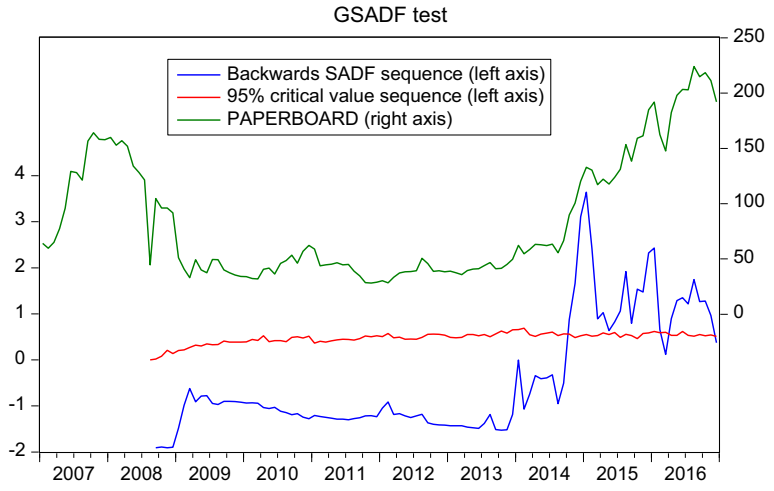

Fig. 16 Paper and board

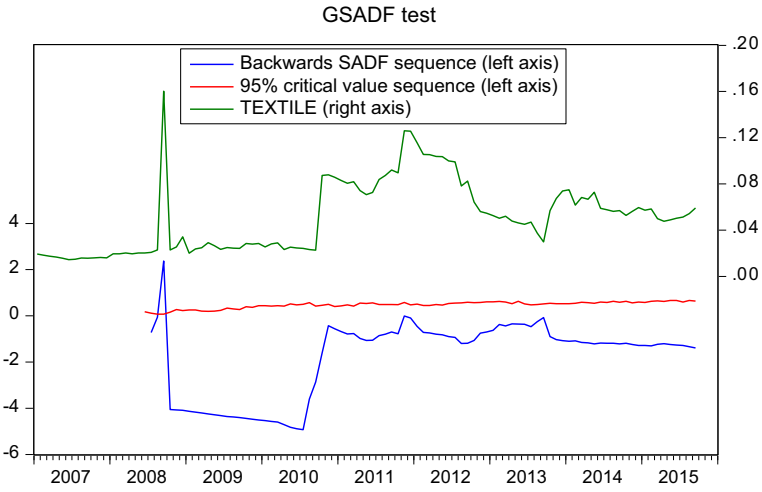

Fig. 17 Textile composite

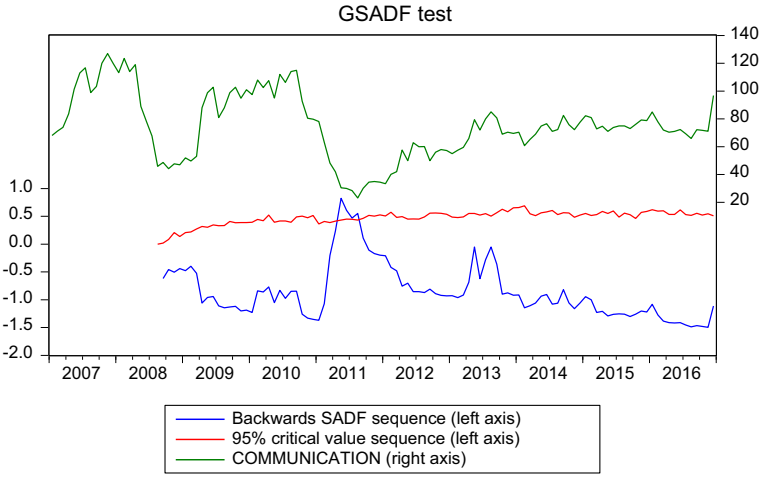

Fig. 18 Transportation and communication

of Pakistan Stock Exchange as depicted by Figs. 4, 5 and 7, respectively. There are no stock bubbles found in these sectors during the study period.

5 Conclusion

The application of right-tailed GSADF test proposed by Philips et al. (2015a, b) on Pakistan Stock Exchange has enabled us to find the evidence of stock market bubbles in Pakistan during the study period for various industrial sectors as

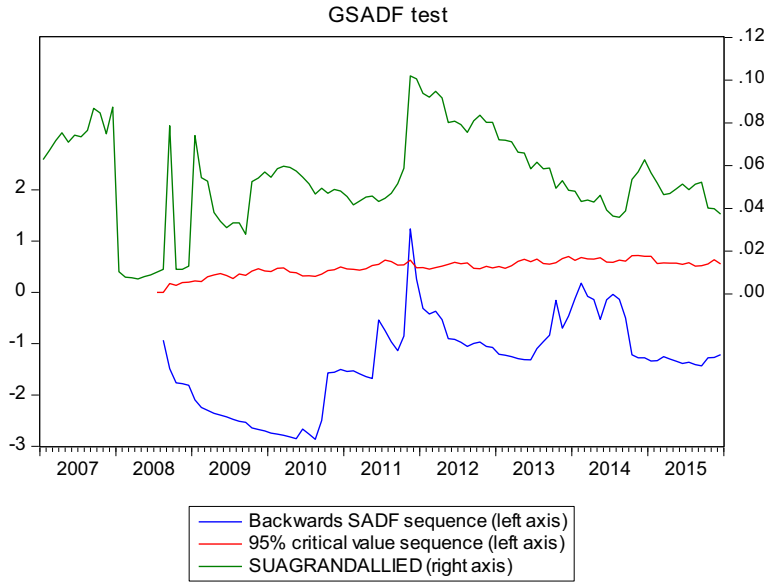

Fig. 19 Sugar and allied industries

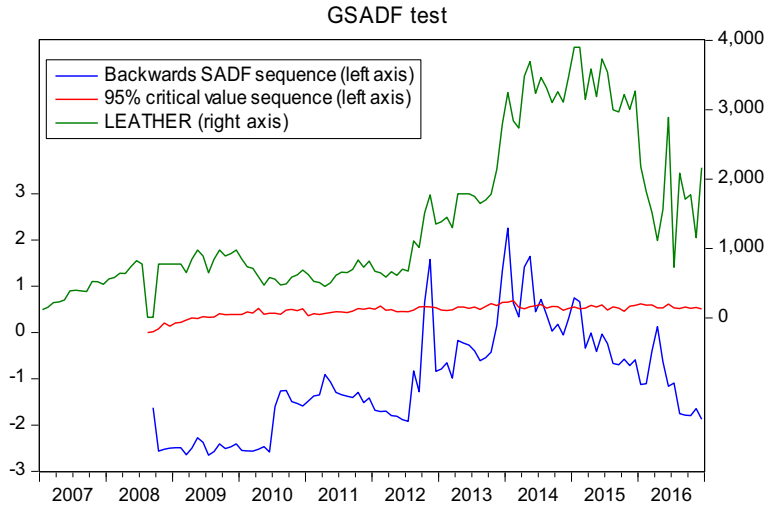

Fig. 20 Leather

well as KSE-100 index. Empirical results depict that Investments, Chemicals and Textile Spinning were the only few sectors where no stock price bubbles were identified by GSADF. In the same context, when we study the equity values of stocks and recent liberalization of Pakistan stock market, we believe that results

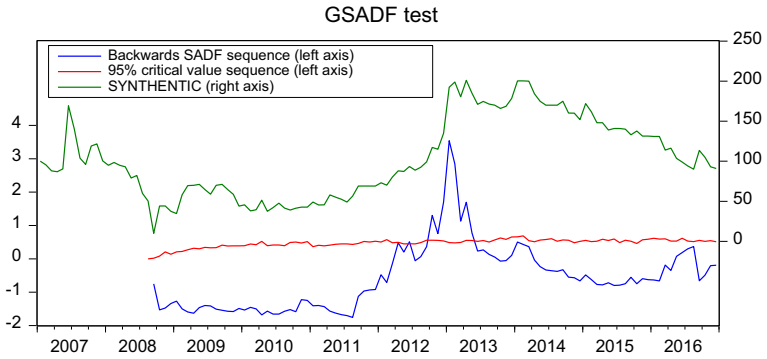

Fig. 21 Synthetic and ryan

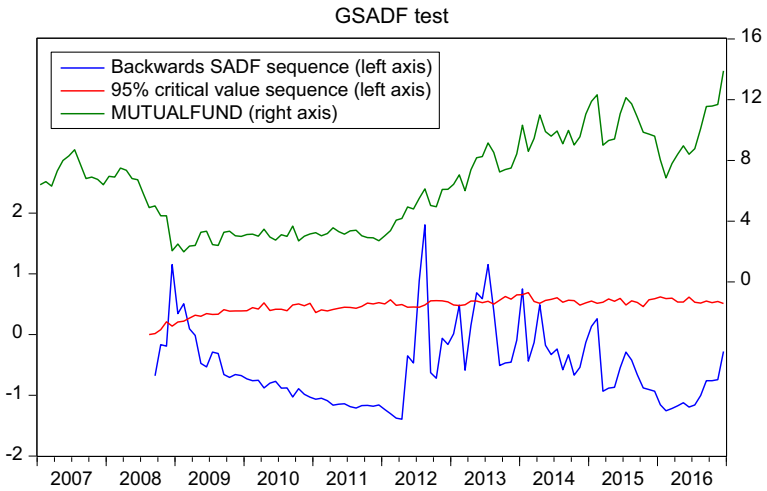

Fig. 22 Close-ended Mutual funds

of bubbles shown in table and figures provide international and domestic investors understanding of fluctuating behavior of Pakistan stock market.

Further, monetary and fiscal policy making authorities need to formulate the policies considering this wealth redistribution impact of stock bubbles in the capital markets. Increased stock price can also increase overall demand which can put upward pressure on inflation. Therefore, regulators need to take restricted action to control the upward pressure on inflation. Bubble in stock market can also be occur due to information asymmetries and information mispricing which might be taken care to enhance the informational efficiency of the capital market. These policy considerations are more significant for the emerging market of Pakistan, as reported by Kasman et al. (2009), emerging markets are supposed to have higher volatility than developed markets and mostly marked by inconsistent and

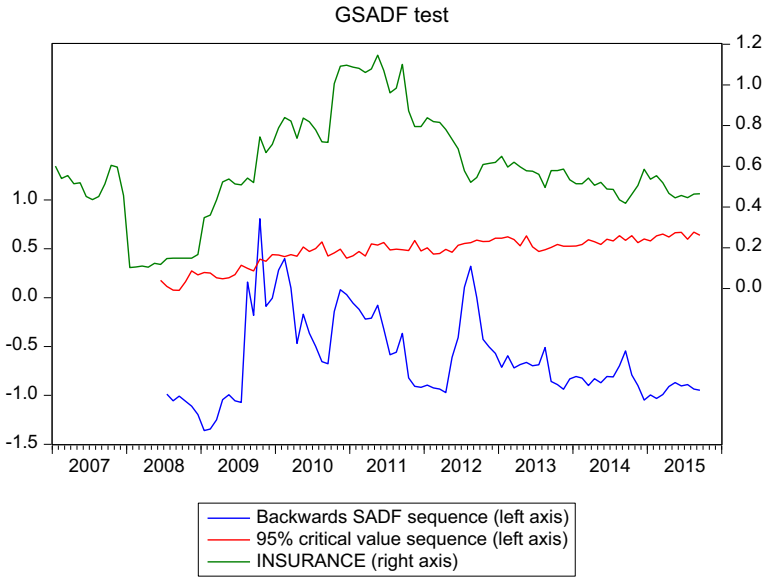

Fig. 23 Insurance

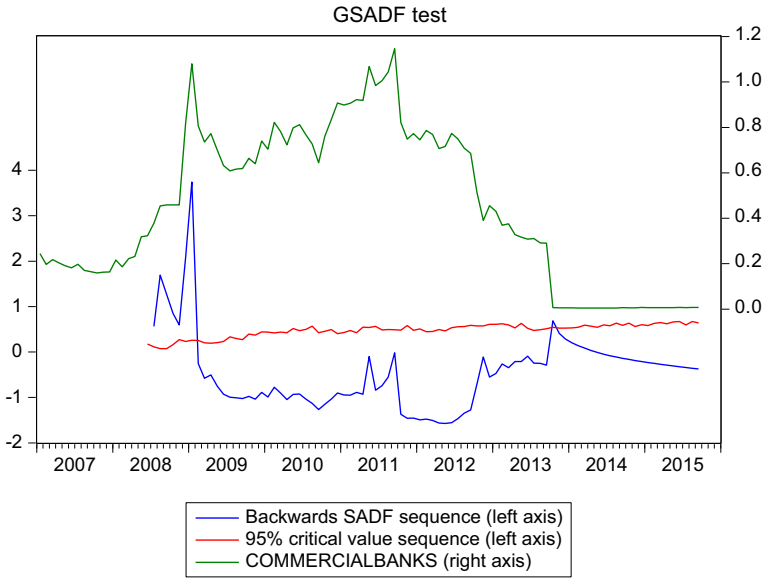

Fig. 24 Commercial banks

frequent changes which are driven by multiple domestic events than global economic activities. Moreover, greater volatility of emerging markets leads to have more speculative activities than in the developed markets. Developed economies

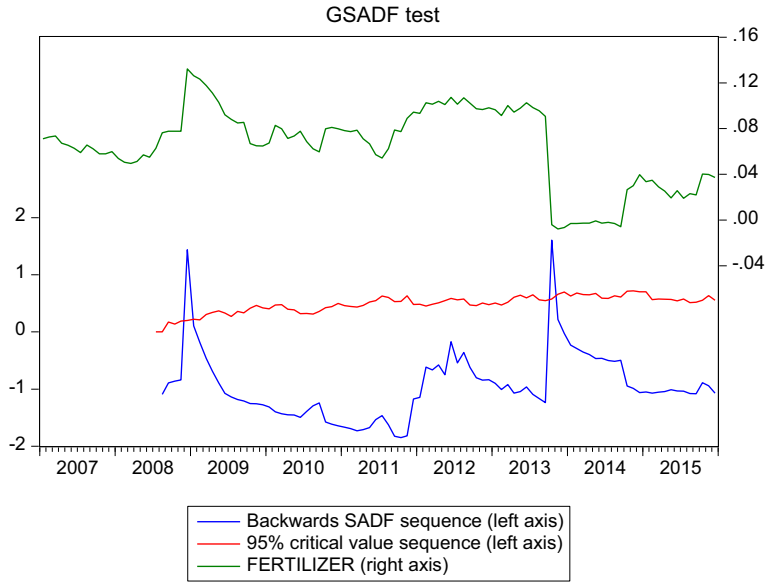

Fig. 25 Fertilizers

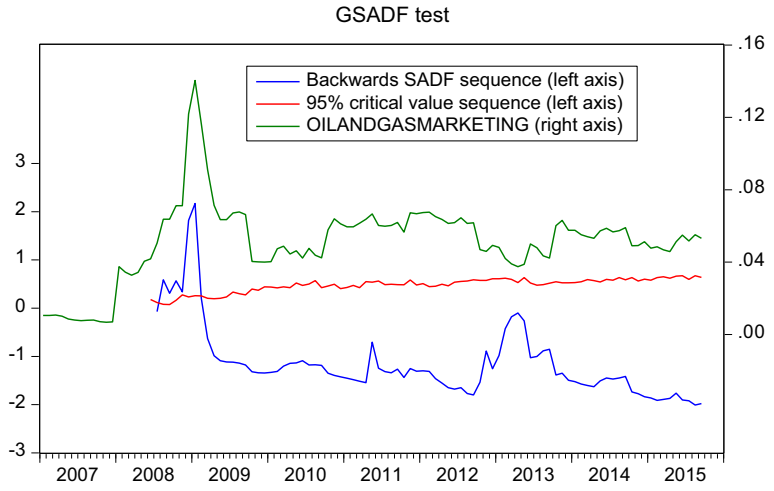

Fig. 26 Oil and gas marketing

have strong and consistent market activities which cause less deviations of stock market prices from market fundamentals.

The formal analysis of the behavior and patterns in Pakistan stock market behavior might help the domestic and international investors in their investment management decisions. Similarly, bubbles identification by this study can help the regulators

to improve the business cycle functioning. As the bubbles are present in Pakistan stock exchange, regulators should take preemptive measures as whenever prices deviate more from their fundamental values, there is always financial crunch occur when bubbles burst. Moreover, policy makers should consider improving transparency of investors information which would reduce the uncertainty about economic environment and strengthen the market by reduce misleading stock prices. Finally, the present study has also certain limitations and hence these can be alleviated by future researchers. Our research just focuses on equity market although other asset classes have also experienced many bubble periods. The present study identifies the time period of bubbles occurrence and certain plausible reasons for these multiple stock bubbles, however; bursting of stock bubbles and their subsequent consequences on equity market and economy should be considered by future studies.

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