Multibubbles in Emerging Stock Markets

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Abstract

Bubbles are deviations of financial asset prices from random walk process and have been present in many stock markets in history. The purpose of the study is detecting bubbles and their beginning and ending dates in ten emerging markets. By the help of Sup Augmented Dickey Fuller (SADF) and Generalized Sup Augmented Dickey Fuller (GSADF) tests, bubble events identified in ten emerging stock markets' main equity indices (BIST100: Turkey, BOVESPA: Brazil, IDX Composite: Indonesia, IPC: Mexico, IPSA: Chile, KOSPI: South Korea, MCX: Russia, NIFTY50: India, QE All Shares: Qatar, WIG20: Poland) for the period from January 2001 to July 2017. The results indicate that all of the emerging stock markets in our sample separated from their random walk more than one time in the 2001-2017 period except WIG20.

Keywords: *Bubble, SADF, GSADF*

Gelişmekte Olan Pay Piyasalarında Çoklu Balonlar

Öz

Finansal varlık fiyatlarının rassal yürüyüş sürecinden ayrılması olarak açıklanan balonlar, tarihte birçok pay borsasında görülmüştür. Çalışmanın amacı, on gelişmekte olan piyasada balonları ve balonların başlangıç ve bitiş tarihlerini tespit etmektir. Sup Augmented Dickey Fuller (SADF) ve Genelleştirilmiş Sup Augmented Dickey Fuller (GSADF) testlerinin yardımıyla, gelişmekte olan pay piyasalarının ana pay endekslerindeki (BIST100: Türkiye, BOVESPA: Brezilya, IDX Compozite: Endonezya, IPC: Meksika, IPSA: Şili, KOSPI: Güney Kore, MCX: Rusya, NIFTY50: Hindistan, QE All Share: Katar, WIG20: Polonya) balonlar, Ocak 2001'den Temmuz 2017'ye kadar olan dönem için belirlenmiştir. Sonuçlar, WIG20 haricinde örneklemimizdeki tüm gelişmekte olan pay piyasalarının rassal yürüyüş süreçlerinden birden fazla kez ayrıldığına işaret etmektedir.

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1. Introduction

According to the traditional finance theories security prices are expected to be around the real value in an efficient market, however the prices can deviate from the random process they should be. Although investors are aware of this separation, they think it is a good chance that they continue to expand and provide a high yield (Mcqueen & Thorley, 1994). Those separations of financial assets from random walking process called price bubble, and also expressed as the separation of a financial asset from its real value (Tirole, 1985). There are many studies examine the factors of bubbles, investigating the presence of bubbles or dating the bubbles. This study is from the one which detects the multibubbles in emerging markets with the help of Sup Augmented Dickey Fuller (SADF) and Generalized Sup Augmented Dickey Fuller GSADF tests. By the help of these tests it is also possible to obtain the dates of bubbles. Especially GSADF test is successful in dating the bubbles more than one time in any period that is the superior qualification of GSADF among many other methodologies.

Tirole (1985) counts the three factors that cause bubbles: durability, scarcity and common beliefs. These common beliefs can also be associated with the behavioral finance approach.

Bubbles are explained by herding behavior in behavioral finance. Contrary to the traditional finance theories, those say that rational investors should maximize their preferences in investment decisions, diversify portfolios and avoid risk; investors are not able to realize these in their financial decisions in the real life. In the other words, investors may not be rational as predicted in traditional financial models. Kahneman and Tversky (1979)'s study is one of the most important studies that psychological elements and the behavioral characteristics of investors should be reflected in the asset pricing models. According to their expectation theory that forms the basis of behavioral finance, more importance is attached to loss against gains by the investors.

Investors ignoring their own knowledge and imitating other investors lead to a herding behavior. Besides, investors in a market making similar decisions in the same directions do not mean that there is always a herding behavior. Especially in efficient markets, the information is available to all investors that they evaluate the information and make transactions in the same direction. While the investors are rational, they make similar investment decisions (Altay, 2008). Buying or selling the same securities without a specific reason, is defined as the herding behavior.

Psychological factors cause investors to make the decision systematically in the same direction. One of the reasons for herding behavior is explained by similar achievements of different investors (Bikhchandani, Hirsleifer & Welch, 2008). After observing that investors traded in the same direction with other investors, and achieved the same result, they begin to follow each other and communicate with each other. This interaction also causes them to make costless decisions in a short period of time. The increase in the number of investors, noise based trading irrational investors and the relative shortness of the investment horizons cause the asset price to deviate from the base value (Shiller, 2003).

Another reason for herding behavior could lead to bubbles is uncertainty. As long as uncertainty is concerned only with the value of the investment, herd behavior would not occur. However, the uncertainty of accuracy of the information available to market participants can be the cause of herding behavior (Avery & Zemsky, 1998).

2. Historical Summary of Bubbles

Bubbles appear at different markets. Although the first known balloon of the stock market appeared in United Kingdom in 1720, the most common example of the first historical example is the Tulipmania. It was alleged that, while the actual price increases were not yet realized in 1633, a house in the city of Hoorn was sold to three rare tulip bulbs, one farm to a parcel tulip bulb, and a Semper Augustus to 5,500 Guilder. In the 1630s, the Dutch people devoted themselves to tulip cultivation and almost all of the arable fields were turned into tulip gardens. At the beginning of 1637, Semper Augustus was sold to the 10,000 Guilder. It was a money that could be paid by all but a few dozen of people in the Netherlands and coinciding with the price of the most beautiful houses in Amsterdam (Dash, 1999:108-110). In the same year with the South

Sea, the Mississippi Bubble took place in France.

Three major real estate bubbles took place in US, Japan and Switzerland in the 20th century. In the real estate bubbles period, although the real estate prices were found expensive, the investors think the future prices would compensate (Case & Shiller, 2003). At the beginning of the 20th century, the working class, enriched by Ford, who was a serial producer, turned into a society of high spending. In previous years this class interested in real estate investments in the southern regions of the US. While they began to sell the real estate investments in falling prices, the investments turned to the equity market. The rapidly rising New York Stock Exchange fell 12.8 % on October 24, 1929.

In the second half of the 1980s, the Japanese economy was above average, with inflation close to zero. These positive developments lowered the risk profile of the country, entered growth expectation, securities prices rose and high credit expansion took place. Although the overvalued Japanese stock market had risen after the Central Bank increased its rediscount ratios at the end of 1989, the Japanese stock market plunged in 1990. Meanwhile, the Ministry of Finance issued announcements in April 1990 to restrict the lending to the real estate sector in order to limit the increase in land prices. At the beginning of 1992, this price bubble collapsed. A similar collapse took place following the rapidly rises of real estate and rent prices in Switzerland beginning from 1989 to 1992.

In the late 1990s, with the technological development, internet based companies have attracted interest. The interest on these companies have also seen as rapid rise in their stock prices. Investors have turned their direction to stocks of internet-based companies with anticipation of great returns. Following the NASDAQ index peak on 5048 on 10th March 2010, selling began. Many studies tried to explain the investor behavior under different models, however the overly optimistic investors simply explain the dot.com bubble (Ljungqvist & Wilhelm, 2003). By the collapse of the bubble, most of the equity of internet based companies suffered from great losses.

The Mortgage Crisis that began in 2007 with stagnation in the housing market and mortgage defaults. In the following year large investment banks' bankruptcies negatively affected internationalized financial markets and the whole world economy. The role of the FED is great when the causes of the crisis are examined. The FED's low interest rates have led to explosions in mortgage lending, especially in subprime mortgage lending. The increase in floating rate loans in this period led to serious problems. The appropriateness of the conditions and the expectation that the same conditions will continue have been dominated by the markets and the credits used have been increased. The increase in housing prices caused speculative demand for housing credits and led to the problem of moral hazard. Besides, the bank managers' high profit and premium expectations caused giving credits to those who do not have appropriate conditions, created a separate moral hazard in the crisis process. The reason why investment banks suffer great losses from the crisis is, they bought securitized mortgage loans and sold them to hedge funds. The banks that have obtained new resources have also gained more credit opportunities.

Table 1. Bubbles in History

Bubble	**Year**	**Market**	**Country**
Tulipmania	1637	Tulip	Netherlands
The South Sea Bubble	1720	Equity	United Kingdom
The Mississippi Bubble	1720	Equity	France
Great Recession	1929	Equity & Real Estate	USA
Japan Real Estate	1992	Equity & Real Estate	Japan
Swiss Real Estate	1989-1992	Real Estate	Switzerland
Dot.com	2001	Equity	USA
Mortgage Crisis	2008	Real Estate	USA

Source: Kıyılar & Akkaya 2016: 236-244; Oran, 2011.

3. Literature

Bubbles are analyzed in many studies since Shiller (1981). A summary of the literature is given on Table 2. These studies related with different markets, applied to different financial instruments' prices or indices, but mostly focused on real estate and equity markets. The methodologies are discussed in some studies as Tirole (1985), and empirical analyzes are applied in many others. Tirole (1985) analyze different tests under seven different positions and focuses on formulations. Study concludes with three main causes of bubbles as durability, scarcity and common beliefs.

While stock prices are compared with dividends by variance bonds tests and regressions in some of them, nonlinearity of returns are discussed in some other (McQueen and Thorley, 1994). The duration dependence of McQueen and Thorley (1994) is applied to different stock markets as in Yanık and Aytürk (2011) to Turkey. Following duration dependence and conditional skewness test of McQueen and Thorley (1994), Chan et al (1998) apply explosiveness tests to six Asian Markets (Hong Kong, Japan, South Korea, Malaysia, Thailand and Taiwan) and US stock market from 1975 to 1994. The bubbles in Hong Kong, Malaysia and Thailand are found explosive, the returns in these markets increase prior to the crash. By the panel data approach, financial crashes that are related rational bubbles are investigated for a panel of 18 OECD countries in the study of Cerqueti and Costantini (2011).

The IPO underpricing is studied by Ljungqvist and Wilhelm (2003) in the frame of dot.com bubble. The extreme optimistic investors are found the main cause of bubbles in the study. In an econometrical approach, Jarrow, Protter and Shimbo (2007; 2010) explains three types of bubble according to the finite or infinite horizons.

Al-Anashaw and Wilfling (2011) use a state-space model with Markow Switching to stock prices. The markow switching model indicates two phases in the bubble process: one in the bubble survives and one in the bubble collapses. Anderson and Brooks (2014) is a good example analyzing bubbles in the individual stock level by bubble CAPM. While the bubble deviation opposite to industry or market level is determined, it stands out that covariances with bubbles at the level of the market as a whole might be important in driving stock returns.

Evidence on bubbles in equities and equity indices have been found many times in the literature. Variance bond tests, runs tests, cointegration and duration dependence tests are some of the tests applied to detect bubbles. SADF and GSADF tests are new and popular tests in recent studies. Especially random and explosive processes are successfully distinguished from each other in GSADF model (Philips et al., 2012; 2015). These models have been applied to different markets. Chen and Funke (2012), Betendorf and Chen (2013), Gonzalez (2013), Pavlidis et al. (2013), Wan (2014), Zeren and Ergüzel (2015) and Erer et al (2017) are some of the studies analyzed bubbles by SADF and GSADF tests. Betendorf and Chen (2013) detected the bubbles Sterling-dollar exchange rate, Escobari and Jafarinejad (2015) on real estate investment trust indices, Chen and Funke (2012), Zeren and Ergüzel (2015) housing and Korkmaz et al. (2016) on credits. Pavlidis et al (2013) find bubbles in most of 22 countries' housing market. Those different studies in literature find SADF and GSADF tests successful for identifying the disconnections of markets from their fundamentals.

Table 2. Literature Summary

Study	Methodology	Study	Methodology
Shiller, 1981	Variance bound tests	Chen & Funke, 2012	GSADF
LeRoy and Porter	Variance bound tests	Phillips, Shi & Yu, 2012	GSADF
Santoni, 1987	Runs test	Bettendorf & Chen, 2013	GSADF
West, 1987	Specification tests	Anderson & Brooks, 2014	Bubble CAPM
Diba and Grossman, 1988a and 1998b	Integration and Cointegration test	Pavlidis et al, 2013	GSADF
Blanchard & Watson, 1982	Runs tests, Tail tests	Wan, 2013	GSADF
Chan et al, 1998	Duration dependence test, Conditional skewness tests, Explosiveness tests	Phillips, Shi & Yu, 2015a, 2015b	GSADF
Case & Shiller, 2003	Survey	Escobari & Jafarinejad, 2015	GSADF
Gürkaynak, 2008	Variance Bounds Tests, West's two-step tests, Integration/ cointegration based tests	Zeren & Ergüzel, 2015	GSADF
Al-Anashaw & Wilfling, 2011	A state-space model with Markow Switching	Korkmaz, Erer & Erer, 2016	GSADF
Jarrow, Kchia, Protter, 2011	Reproducing Kernel Hilbert Spaces	Erer, et al., 2017	SADF
Yanık & Aytürk, 2011	Duration dependence test		

4. Data

The dataset covers ten emerging stock markets' main equity indices. These main equity indices are analyzed beginning from January 2001 to July 2017. (BIST100: Turkey, BOVESPA: Brazil, IDX Composite: Indonesia, IPC: Mexico, IPSA: Chile, KOSPI: South Korea, MCX: Russia, NIFTY50: India, QE All Shares: Qatar, WIG20: Poland). Monthly observations used are obtained from investing.com. The assumption of the study is that the indices of selected emerging countries settled in the global financial portals such as finance.yahoo.com, investing.com, Bloomberg.com and BBC Business followed by the international investors.

5. Methodology

5.1. Sup Augmented Dickey Fuller Test

Sup Augmented Dickey Fuller Test, which is one of the right-tailed unit root tests is developed by Philips, Si and Yu (2011). The analysis allowed for a null random walk process with an asymptotically negligible drift.

$$yt = dT^{-\eta} + \emptyset yt - 1 + \varepsilon_t, \varepsilon_t \sim^{iid} N(0, \alpha^2), \emptyset = 1; \quad (1)$$

d: constant,

T: sample size,

$\eta > ½$

The recommended empirical regression model for bubble detection in formula (1) above includes an intercept but no fitted time trend in the regressi-

on. Suppose a regression sample starts from the r_1^{th} fraction of the total sample and ends at the r_{12}^{th} fraction of the sample, where $r_2 = r_1 + r_w$ and r_w is the (fractional) window size of the regression. The empirical regression model can be written as follows:

$$\Delta y_t = \propto_{r_1 r_2} + \beta_{r_1 r_2} y_{t-1} + \sum_{i=1}^{k} \varphi^{\,i}_{r_1 r_2} \Delta y_{t-i} + \varepsilon_t; \quad (2)$$

k: lag order,

$$\varepsilon_t \sim^{iid} N(0, \alpha^2_{r_1 r_2}),$$

$T_w = \lfloor T r_w \rfloor$: Number of the observations in the regression

ADF statistic (t ratio) based on this regression is signified by $ADF_{r_1}^{r_2}$

This right tailed unit root test estimates the Augmented Dickey Fuller (ADF) model repeatedly on a forward expanding sample sequence conducts a hypothesis test based on the sup value of the corresponding ADF statistic sequence.

r_w: window size

window size expands from r_0 to 1.

The ending point of each sample r_2 is equal to r_w .

The ADF statistic for a sample that runs from 0 to r_2 is denoted by $ADF_0^{r_2}$. The SADF statistic is defined as $\sup_{r2} \in [r_0;1]\ ADF_0^{r_2}$; and is denoted by SADF (r_0).

5.2. Generalized Sup Augmented Dickey Fuller Test

The GSADF test continues the idea of repeatedly running the ADF test regression (2) on a sample sequence. However, the sample sequence is broader than that of the SADF test. GSADF test allows the starting point r_1 to change within a feasible range, which is from 0 to $r_2 - r_0$. GSADF statistic defined to be the largest ADF statistic over the feasible ranges for r_1 and r_2, and signified by GSADF(r_0) (Philips et al., 2012; 2015(a); 2015 (b)).

$$GSADF(r0) = \sup_{\substack{r_2 \epsilon [r_0, 1] \\ r_1 \epsilon [0, r_2 - r_0]}} \{ADF_{r_1}^{r_2}\}; \quad (3)$$

Including an intercept in the regression model and the null hypothesis is a random walk without drift (i.e. dT^n with $n > ½$ and constant d), the limit distribution of the GSADF test statistic is can be written as follows:

$$\sup \left\{ \frac{\frac{1}{2} r_w [W(r_2)^2 - W(r_1)^2 - r_w] - \int_{r_1}^{r_2} W(r)dr\,[W(r_2) - W(r_1)]}{r_w^{\frac{1}{2}} \left\{ r_w \int_{r_1}^{r_2} W(r)^2 dr - \left[\int_{r_1}^{r_2} W(r)dr\right]^2 \right\}^{\frac{1}{2}}} \right\}$$
$$r_2 \epsilon [r_0, 1]$$
$$r_1 \epsilon [0, r_2 - r_0] \quad (4)$$

$r_w = r_2 - r_1$ and W is a standard Wiener process.

The asymptotic GSADF distribution depends on the smallest window size r_0. If total number of observations (T) is small, r_0 needs to be large enough to ensure there are enough observations for adequate initial estimation. If T is large r_0 can be set to be a smaller number, thus the test does not miss any opportunity to detect an early explosive episode (Phillips, Shi and Yu (2012)).

Random and explosive processes are successfully distinguished from each other in GSADF model. It is a dominant model in analyzing speculative movements and behavioral anomalies in the market.

6. Empirical Results

The empirical analysis is composed of two steps. In the first step, the descriptive characteristics as normality and skewness of series are identified. Secondly, the bubbles in prices are analyzed in Eviews 9 programme by the Sup Augmented Dickey Fuller Test (SADF) and Generalized Sup Augmented Dickey Fuller Test (GSADF).

The descriptive statistics of the variables are shown in Table 3. While the monthly closing prices of BIST100, BOVESPA, IPC, IPSA, KOSPI MICEX and QE skewed to the left (left-skewed); the closing prices of IDX Composite, NIFTY50 and WIG20 skewed to the right (right-skewed).

The kurtosis of the monthly closing prices of all indices are less than 3. These series have lighter tails than a normal distribution, in other words these series have light-tailed distributions.

Table 3. Descriptive Statistics

	BIST100	BOVESPA	IDX COMPOSITE	IPC	IPSA	KOSPI	MICEX	NIFTY50	QE	WIG20
Mean	48216.24	43811.81	2698.292	27762.91	3011.136	1505.907	1199.178	4545.361	7731.784	2201.832
Median	47184.71	50055.30	2444.349	30347.86	3255.320	1692.850	1396.610	4870.100	8393.920	2275.300
Maximum	107531.4	72592.50	5840.940	51011.87	5064.620	2402.710	2232.720	10077.10	13728.31	3877.620
Minimum	7625.870	8622.540	358.2320	5403.530	927.4700	479.6800	158.1000	913.8500	1170.540	1022.620
Std. Dev.	26179.35	19016.87	1781.179	14481.92	1245.137	541.8182	569.7148	2533.737	3261.152	632.5206
Skewness	-0.000725	-0.482344	0.158398	-0.231122	-0.261969	-0.467179	-0.446285	0.174347	-0.471631	0.245989
Kurtosis	1.789837	1.855792	1.533757	1.609441	1.682430	1.751596	1.881967	1.963477	2.396183	2.822401
Jarque-Bera	12.14312	18.57196	18.65815	17.80490	16.67041	20.16150	16.97037	9.916558	10.40054	2.268467
Probability	0.002308	0.000093	0.000089	0.000136	0.000240	0.000042	0.000207	0.007025	0.005515	0.321669
Observations	199	199	199	199	199	199	199	199	199	199

The test statistics for SADF and GSADF tests are given in Tables 4 to 13. The statistics are compared with the critical values obtained from the Monte Carlo simulation with 1000 replications for each observation. By the help of the Figures 1 to 10, the dates when bubbles took place are investigated. The prices are shown with the line in the dark colour, critical values with the line in the medium colour and the calculated sequences with the line in the light colour. Generally, the areas of the line in the light colour above the critical values, indicate bubble possibilities.

The tests results for BIST100 are given in Table 4. Both statistics of SADF (2.355945) and GSADF (2.543250) identified the whole period as having price bubbles. According to the periods in Figure 1, bubbles have been seen two times in BIST100, in 2015 and in 2017. Although there are three major ups and downs in the following periods (2010, 2012-2013, 2014), these movements are not identified as separations from random walk process by the SADF and GSADF tests.

As shown in Table 5, statistics of SADF (3.390614) and GSADF (3.390614) identified the whole period for BOVESPA as having price bubbles. The price movements after 2008 are not defined asfor BOVESPA.

According to Table 6, statistics of SADF (3.696602) and GSADF (3.696602) identified the whole period as having price bubbles for IDX Composite. While SADF test finds one big bubble beginning from 2004 to 2008 and another bubble beginning from 2010 to 2013 for IDX Composite, GSADF analyzes the first period as four different bubbles and finds three small separating movements from random walk process (Figure 3). However, these movements in 2010, 2011 and 2013 are not strong enough to explain as bubbles.

As the tests statistics of SADF and GSADF for IPC (4.034053) are not different from each other, the figures are not too different too. The big bubbled indicated by SADF test is defined nearly for the whole the same 2004 -2007 period in GSADF either. On the other hand, the movements in the following periods are not identified as separations from random walk process.

As shown in Table 8, the tests statistics of SADF and GSADF for IPSA (3.497390) are same. In the following Figure 5, three bubbles are found for IPSA in both two tests. These bubbles take place in 2005, 2007 and 2010. Because the growth rate of Chile reach it’s highest value in the fourth quarter of 2010, this bubble should not related with the high liquidity in international financial markets.

Table 4. Test Statistics for SADF and GSADF – BIST100

		Finite Sample Critical Values		
	Test Stat.	90%	95%	99%
BIST100	Window size: 27			
SADF	2.355945 (p: 0.0030)	1.097977	1.395577	1.938444
GSADF	2.543250 (p: 0.0150)	1.872442	2.095168	2.830079

Table 5. Test Statistics for SADF and GSADF – BOVESPA

		Finite Sample Critical Values		
	Test Stat.	90%	95%	99%
BOVESPA	Window size: 27			
SADF	3.390614 (p: 0.0000)	1.097977	1.395577	1.938444
GSADF	3.390614 (p: 0.0000)	1.872442	2.095168	2.830079

Table 6. Test Statistics for SADF and GSADF – IDX COMPOSITE

		Finite Sample Critical Values		
	Test Stat.	90%	95%	99%
IDX COMPOSITE	Window size: 27			
SADF	3.696602 (p: 0.0000)	1.097977	1.395577	1.938444
GSADF	3.696602 (p: 0.0000)	1.872442	2.095168	2.830079

Table 7. Test Statistics for SADF and GSADF – IPC

		Finite Sample Critical Values		
	Test Stat.	90%	95%	99%
IPC	Window size: 27			
SADF	4.034053 (p: 0.0000)	1.097977	1.395577	1.938444
GSADF	4.034053 (p: 0.0000)	1.872442	2.095168	2.830079

Table 8. Test Statistics for SADF and GSADF – IPSA

		Finite Sample Critical Values		
	Test Stat.	90%	95%	99%
IPSA	Window size: 27			
SADF	3.497390 (p: 0.0000)	1.097977	1.395577	1.938444
GSADF	3.497390 (p: 0.0000)	1.872442	2.095168	2.830079

Table 9. Test Statistics for SADF and GSADF – KOSPI

		Finite Sample Critical Values		
	Test Stat.	90%	95%	99%
KOSPI	Window size: 27			
SADF	1.875128 (p: 0.0140)	1.097977	1.395577	1.938444
GSADF	2.053594 (p: 0.0610)	1.872442	2.095168	2.830079

Table 10. Test Statistics for SADF and GSADF – MICEX

		Finite Sample Critical Values		
	Test Stat.	90%	95%	99%
MICEX	Window size: 27			
SADF	3.795826 (p: 0.0000)	1.097977	1.395577	1.938444
GSADF	3.795826 (p: 0.0000)	1.872442	2.095168	2.830079

Table 11. Test Statistics for SADF and GSADF – NIFTY50

		Finite Sample Critical Values		
	Test Stat.	90%	95%	99%
NIFTY50	Window size: 27			
SADF	3.365914 (p: 0.0000)	1.097977	1.395577	1.938444
GSADF	3.365914 (p: 0.0000)	1.872442	2.095168	2.830079

Table 12. Test Statistics for SADF and GSADF – QE All Shares

		Finite Sample Critical Values		
	Test Stat.	90%	95%	99%
QE All Shares	Window size: 27			
SADF	4.806981 (p: 0.0000)	1.09977	1.395577	1.938444
GSADF	4.806981 (p: 0.0000)	1.872442	2.095168	2.830079

Table 13. Test Statistics for SADF and GSADF – WIG20

		Finite Sample Critical Values		
	Test Stat.	90%	95%	99%
WIG20	Window size: 27			
SADF	1.589290 (p: 0.0280)	1.097977	1.395577	1.938444
GSADF	1.863961 (p: 0.1020)	1.872442	2.095168	2.830079

The tests results for KOSPI are given in Table 9. The test statistics of SADF (1.875128) and GSADF (2.053594) show the evidence of bubbles. Two bubbles are found for KOSPI in both SADF and GSADF tests (Figure 6). These bubbles take place in 2005 and 2007. The price movements at the end of 2010 and in the beginning of 2011 are also not defined as bubbles.

Table 10 represents the test statistics of SADF (3.795826) and GSADF (3.795826) for MICEX. The results indicate evidence of bubbles. The following Figure 7 shows a strong bubble in the period beginning from 2006 to 2007 in both tests. Additionally, the price movements after 2008 are not defined as bubbles for MICEX.

Table 11 shows the test statistics for NIFTY50. The 2005-2007 period's big bubble in two tests for NIFTY50 are not too different (Figure 8). Besides, when compared to SADF, GSADF indicate a stronger bubble at the end of 2003.

The test statistics of SADF and GSADF are same (4.806981) according to Table 12. While SADF test finds only one bubble for QE All Share in the period beginning from 2003 to 2005, GSADF indicates a second bubble at the beginning of 2014 (Figure 9). The results of QE All Share are the only example in which GSADF finds a different bubble against SADF.

WIG20 is the only Index which GSADF test do not find bubble for the whole period. While test statistic in Table 13 and Figure 10 considered together, the period beginning from 2005 to 2007 is captured as bubble for SADF test. However, GSADF test does not define these price movements as bubbles.

7. Conclusion

With the separations of financial assets prices from random walking process, there have been bubbles in many times in financial markets. The most known bubbles in history have been seen in real estate markets and equity markets. The South Sea Bubble (UK) and The Mississippi Bubble (France) are the first examples among all of the equity bubbles.

Our study focuses on detecting the bubbles in 10 emerging stock markets. SADF test and one of the newest bubble test GSADF which is strong to define more than one bubble in a period are used to define bubbles. By the help of the figures which are obtained from the tests, the historical periods of bubbles are defined.

Our SADF and GSADF results indicate that all of the emerging markets in our sample separated from their random walk more than one time in the 2001-2017 period, except WIG20. Another attracting result belongs to IPSA and QE All Share. While the bubbles are defined for whole sample before 2008, only IPSA and QE All Share tests have evidence on bubbles in the period beginning from 2008.

Figure 1. SADF & GSADF for BIST100 (Turkey)

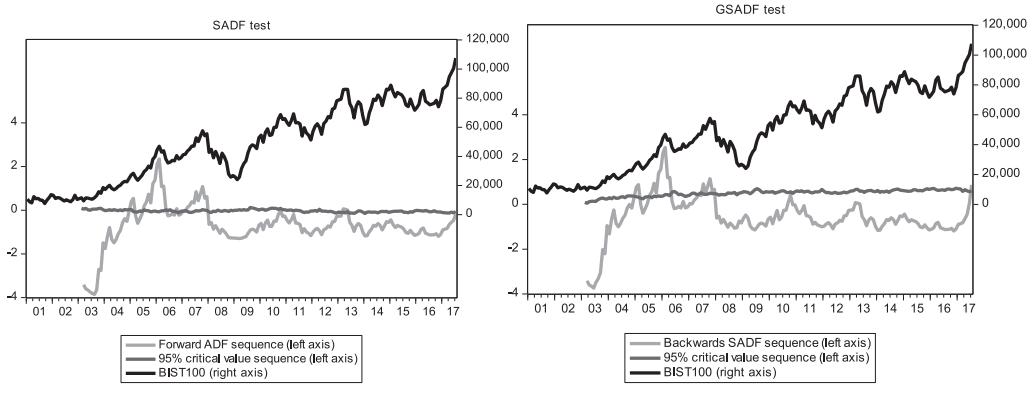


Figure 2. SADF & GSADF for Bovespa (Brazil)

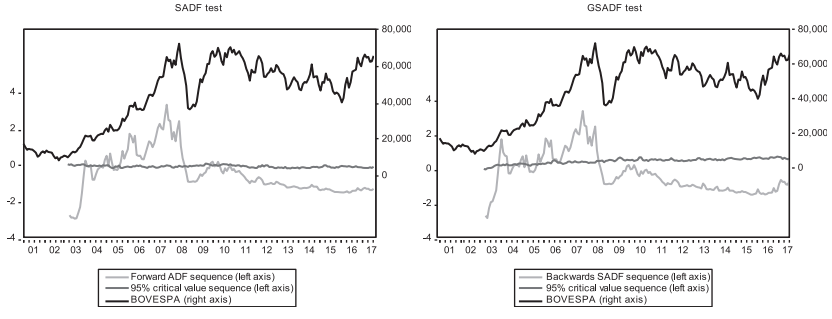


Figure 3. SADF & GSADF for IDX Composite (Indonesia)

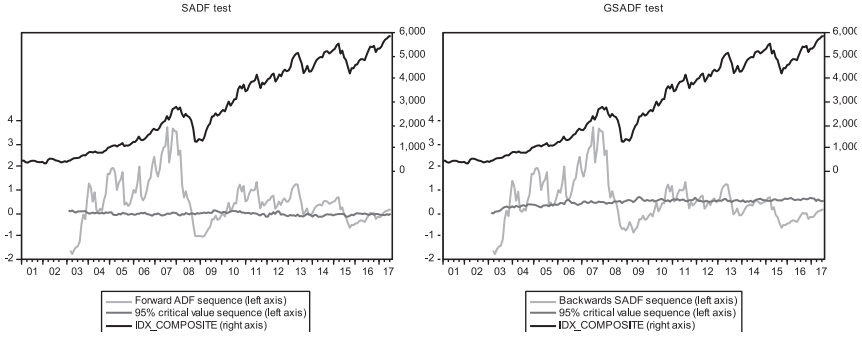


Figure 4. SADF & GSADF for IPC (Mexico)

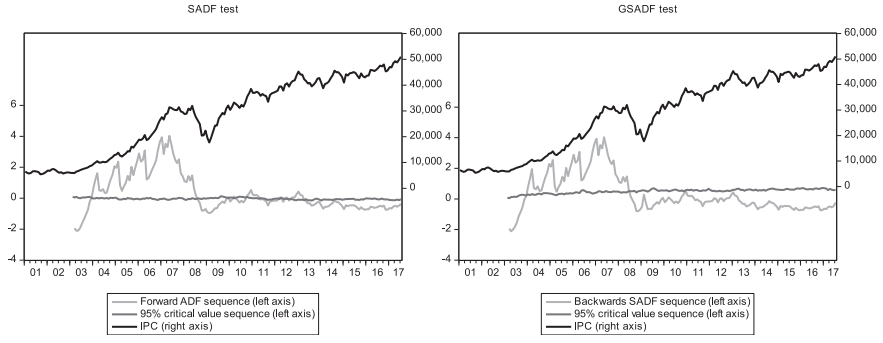


Figure 5. SADF & GSADF for IPSA (Chile)

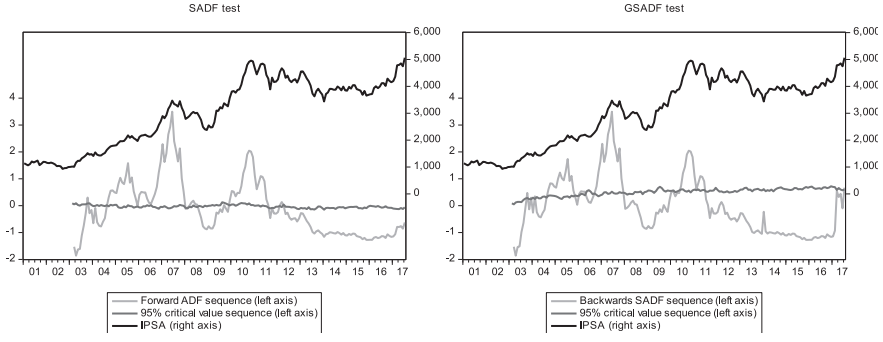


Figure 6. SADF & GSADF for KOSPI (South Korea)

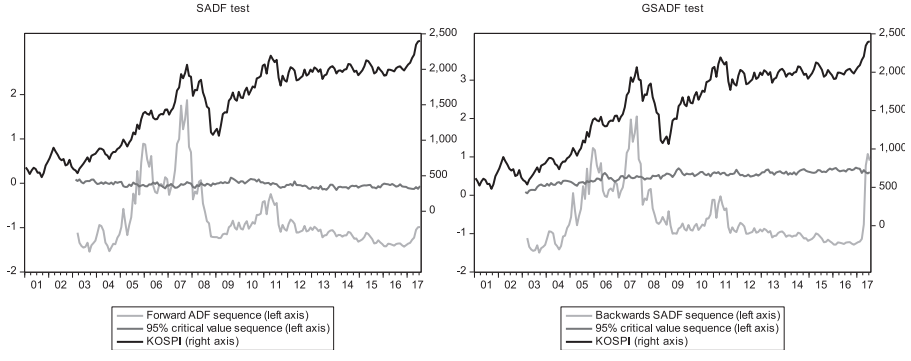


Figure 7. SADF & GSADF for MICEX (Russia)

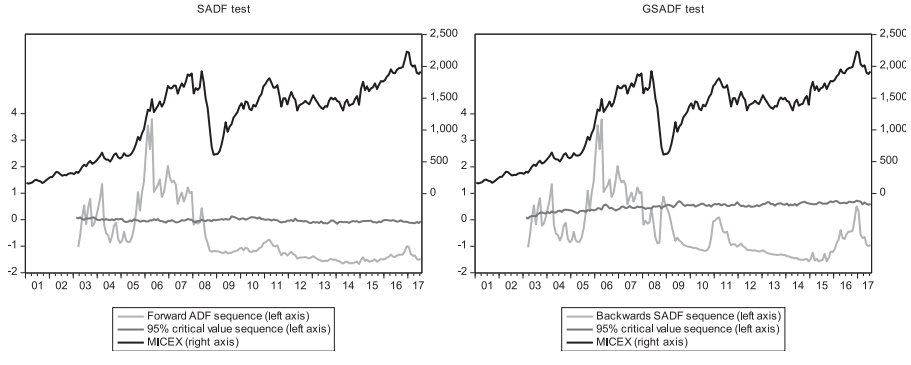


Figure 8. SADF & GSADF for NIFTY50 (India)

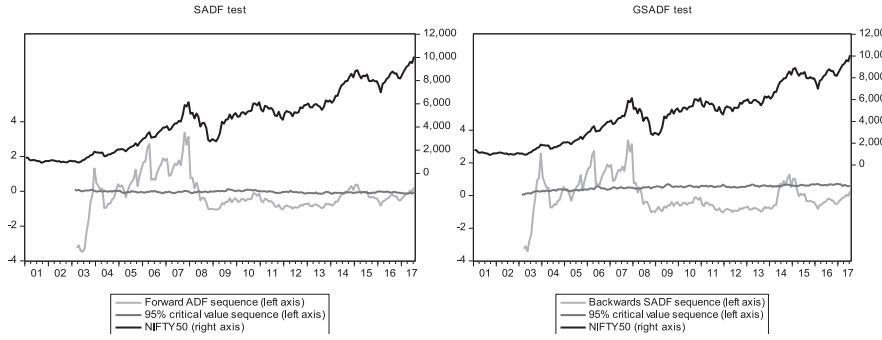


Figure 9. SADF & GSADF for QE All Share (Qatar)

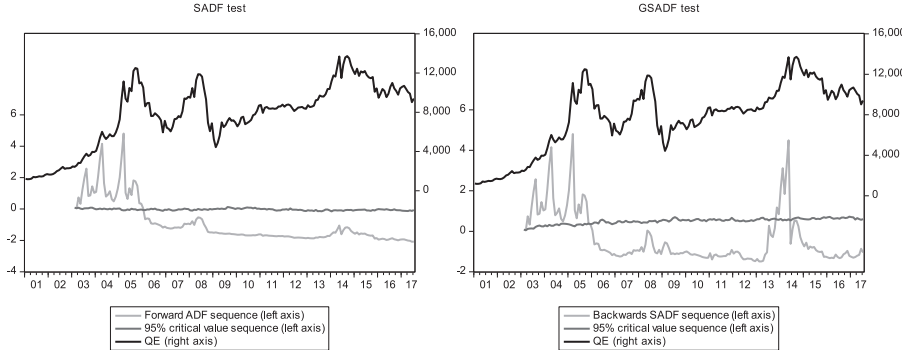
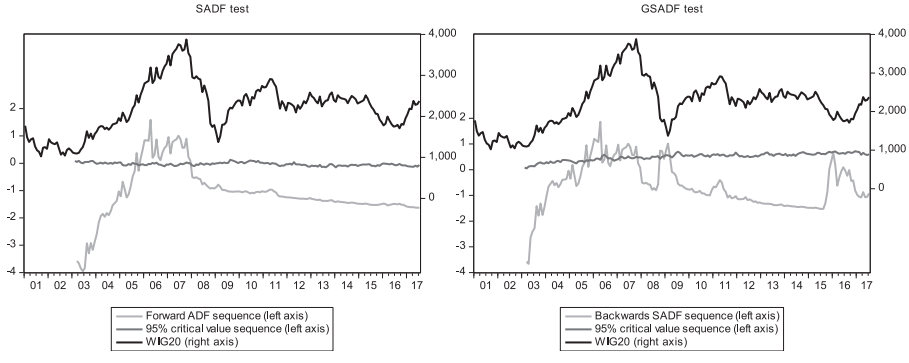


Figure 10. SADF & GSADF for WIG20 (Poland)



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