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February 2014
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ABSTRACT

In this study, we apply a new recursive test proposed by Philips et al (2013) to investigate whether there exist multiple bubbles in the BRICS (Brazil, Russia, India, China and South Africa) stock markets, using monthly data on stock price-dividend ratio. Our empirical results, the first of its kind for these economies, indicate that there did exist multiple bubbles in the stock markets of the BRICS. Further, the dates of the bubbles also corresponded to specific events in the stocks markets of these economies. This finding has important economic and policy implications.

Keywords: Multiple bubbles; BRICS stock markets; GSADF test

JEL: C12, C15, G12, G15

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I. Introduction

This paper examines whether multiple bubbles exist in the BRICS (Brazil, Russia, India, China and South Africa) stock markets during the 1990 to 2013 period using a new test proposed by Philips et al (2013). Bubbles are an observable economic phenomenon. Different series of theoretical setups for bubbles detection are presented in Thompson and Hickson (2006). However, bubbles manifests mainly in three different ways: First naturally, such as the bubble component on fiat money that appears due to confidence and convenience throughout agents transactions; second, due to Informational monopolies, like when some big institutional traders have privileged information about an specific company, and they manipulate the market creating an specific company’s stock price boom; and third through the coalition of governments plus running elites, who together prepare and generate economic events that involve a major part of society (Jiménez, 2011). The occurrence of rational bubbles signifies that no long-run relationships exist between stock prices and dividends. A vast amount of research has been devoted to investigating the presence of rational bubbles in stock markets (Campbell and Shiller, 1987; Diba and Grossman, 1988a, 1988b; Johansen, 1988; Johansen and Juselius, 1990; Froot and Obstfeld, 1991; Timmermann, 1995; Crowder and Wohar, 1998; Barnett and Serletis, 2000; Bohl, and Henke 2003; Nasseh and Strauss, 2004; Cunado et al, 2005; Mokhtar et al., 2006; Chang et al., 2007, Jahan-Parvar and Waters, 2010, and among others) over the past three decades. In pursuit of determining whether or not stock prices and dividends are cointegrated, empirical studies have, for the most part, employed cointegration techniques. Among the most notable of these techniques is the widely employed Johansen cointegration test (Johansen, 1988; Johansen and Juselius, 1990), which is based on the linear autoregressive model and assumes that the underlying
dynamics are in a linear form. From a theoretical perspective, there is no sound reason to assume that economic systems are intrinsically linear (see, Barnett and Serletis, 2000). In fact, numerous studies have empirically demonstrated that financial time series, such as stock prices, exhibit nonlinear dependencies (see, Hsieh, 1991; Abhyankar et al., 1997). In addition, substantive evidence from the Monte Carlo simulations in Bierens (1997, 2004) has indicated that, inherent to the conventional Johansen cointegration framework, there is a misspecification problem when the true nature of the adjustment process is nonlinear and that the speed of adjustment varies with the magnitude of the disequilibrium. A recursive method, supremum Augmented Dickey-Fuller (SADF) have also been proposed by Phillips et al. (2011) which can detect exuberance in asset price series during an inflationary phase. However, the Phillips et al. (2011) recursive method is especially effective when there is a single bubble episode in the sample data as in the 1990s Nasdaq episode analyzed in Phillips et al. (2011) and in the 2000s U.S. house price bubble analyzed in Phillips and Yu (2011). Therefore, given the possibility of multiple bubbles within the same sample period, this study investigates whether multiple bubbles exist in the BRICS stock markets using a new test, generalized sup Augmented Dickey-Fuller (GSADF) test, proposed by Philips et al. (2013). The major advantage of the approach is that it allows one to account for the nonlinear structure and break mechanisms while investigating the existence of multiple bubbles. To the best of our knowledge, this is the first study to test for bubbles in the BRICS stock markets. We utilize the GSADF test to investigate the existence of multiple bubbles in the BRICS stock markets given that emerging markets stock markets are generally characterized by higher volatility than developed economies markets (Barkoulas et al., 2000; Kasman et al, 2009), often marked by frequent and erratic changes, which are usually driven by various local events than events of global importance (Bekaert and Harvey, 1997; Aggarwal et al.,
Our empirical results indicate that multiple bubbles exist in the BRICS countries.

The paper is organized as follows: Section 2 briefly describes the theoretical framework and the econometric methodology proposed by Philips et al. (2011) and Philips et al. (2013). Section 3 presents the data used in our study, while and Section 4 discusses the empirical results and some policy implications. Section 5 concludes the paper.

II. Theoretical Framework and Econometric Methodology

Based on the Campbell et al. (1997), Cuñado et al. (2005), and Koustas and Serletis (2005), our model of the net simple return on a stock is defined as the follows:

\[
SR_{t+1} = \frac{P_{t+1} - P_t + D_{t+1}}{P_t} = \frac{P_{t+1} + D_{t+1}}{P_t} - 1, \tag{1}
\]

where \(SR_{t+1}\) denotes the stock return in period \(t+1\) and \(D_{t+1}\) is the dividend in period \(t+1\). Taking the mathematical expectation on Eq. (1), based on information available at time \(t\), and rearranging terms, we can obtain

\[
P_t = E_t \left[ \frac{P_{t+1} + D_{t+1}}{1 + SR_{t+1}} \right]. \tag{2}
\]

We can solve Eq. (2) forward \(k\) periods and obtain the following semi-reduced form

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

To yield a unique solution to Eq. (3), we assume that the expected discounted value of the stock in the indefinite future converges to zero:
Based on the convergence assumption, we can get the fundamental value of the stock as the expected present value of future dividends:

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

(5)

If we get out of the convergence assumption, then Eq. (4) can lead to an infinite number of solutions and any one of which can be written in the following form

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

(6)

Here, the additional term \( B_t \) is called a “rational bubble”, in the sense that it is entirely consistent with rational expectations and the time path of expected returns. Diba and Grossman (1988b) also define a rational bubble to be a self-confirming divergence of stock prices from market fundamentals in response to extraneous variables. If the nonstationarity of dividends accounts for the nonstationarity of stock prices, then stock prices and dividends are cointegrated. The null hypothesis of rational bubbles can be tested by testing for the cointegrating relationship between dividends and stock prices. A cointegrating relationship between dividends and stock prices is inconsistent with rational bubbles. Understandably, the stationarity of the dividend-price ratio would also imply the same.

However, in the econometric literature, identifying a bubble in real time has proven to be a huge challenge. Econometric techniques suffered from finite sample bias. For example, conventional unit root and cointegration tests may be able to detect one-off exploding speculative bubbles but are unlikely to detect periodically collapsing
bubbles. In other words, efforts to identify significant warning signs of future stock price bubbles have been impeded by the necessity to spot multiple starting and ending points. The reason is that conventional unit root tests are not well equipped to handle changes from I(0) to I(1) and back to I(0). This makes detection by cointegration techniques harder, due to bias and kurtosis (Evans, 1991).¹

Recently, an innovative and persuasive approach to identification and dating multiple bubbles in real time has been pioneered by Phillips and Yu (2011) and Phillips et al. (2013). The idea is to spot speculative bubbles as they emerge, not just after they have collapsed. Their point of departure is the observation that the explosive property of bubbles is very different from random walk behaviour. Correspondingly, they have developed a new recursive econometric methodology interpreting mildly explosive unit roots as a hint for bubbles. Considering the typical difference of stationary vs trend stationary testing procedures for a unit root, we usually restrict our attention to regions of ‘no more than’ a unit root process, i.e. an autoregressive process where \( \delta \leq 1 \). In contrast, Phillips and Yu (2011) model mildly explosive behaviour by an autoregressive process with a root \( \delta \) that exceeds

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¹ Using the standard Johansen (1988) trace and maximum eigen value tests, we found that the null of no cointegration was rejected for Brazil, China and South Africa, while no cointegration could be detected for Russia and India. Given the possibility of nonlinearity in the data generating process of the stocks and dividends and structural breaks in the long-run relationship between these two variables leading to parameter instability, we checked for the robustness of the results from the Johansen (1988) tests by also implementing the Autoregressive Distributed Lag (ADL) test for threshold cointegration, proposed by Li and Lee (2010), as the test can simultaneously investigate nonlinearity and cointegration. The test detected nonlinear cointegration between dividends and stock prices for BRICS. Thus, taking the Johansen (1988) and Li and Lee (2010) cointegration tests together, there seems to be evidence that there exist no rational bubbles in the equity markets of these countries. However, as indicated not much reliance can put on conventional cointegration-based tests as they are not capable of detecting explosive bubbles when they manifest periodically collapsing behavior in the sample. The details of these results are available upon request from the authors.
unity but is still in the neighbourhood of unity. The basic idea of their approach is to calculate recursively right-sided unit root tests to assess evidence for mildly explosive behaviour in the data. The test is a right-sided test and therefore differs from the usual left-sided tests for stationarity. More specifically, consider the following autoregressive specification estimated by recursive least squares

\[ x_t = \mu + \delta x_{t-1} + \sum_{j=1}^{J} \phi_j \Delta x_{t-j} + \epsilon_t \]  

(7)

The usual \( H_0: \delta = 1 \) applies, but unlike the left-sided tests which have relevance for a stationary alternative, 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 these allow for their mildly explosive cases. Phillips and Yu (2011) argue that their tests have discriminatory power, because they are sensitive to the changes that occur when a process undergoes a change from a unit root to a mildly explosive root or vice versa. This sensitivity is much greater than in left-sided unit root tests against stationary alternatives. But this is not all. As we know that bubbles usually collapse periodically. Therefore, conventional unit root tests have limited power in detecting periodically collapsing bubbles. In order to overcome this shortcoming, Phillips and Yu (2011) have suggested using the supremum (sup) of recursively determined Augmented Dickey-Fuller (ADF) \( t \)-statistics. The estimation is intended to identify the time period where the explosive property of the bubble component becomes dominant in the stock price process. The test is applied sequentially on different subsamples. The first subsample contains observations from the initial sample and is extended forward until all observations of the complete sample are included in the tests. The beginning of the bubble is estimated as the first date when the ADF \( t \)-statistic is greater than its corresponding critical value of the right-sided unit root test. The end of the speculative bubble will be determined as the first period when
the ADF $t$-statistic is below the aforementioned critical value.

Following Phillips et al. (2011, 2013) we can calculate a sequence of ADF tests. Let \( \hat{\delta}_r \) denote the OLS estimator of \( \delta \) and \( \hat{\sigma}_{\delta r} \) the usual estimator for the standard deviation of \( \hat{\delta}_r \) using the subsample \( \{x_1, x_2, ..., x_{T_r}\} \). The forward recursive ADF test of \( H_0 \) against \( H_a \) is given by

\[
SADF(r_0) = \sup_{r_0 \in [0,1]} \{ADF(r)\}
\]

where \( ADF = \frac{\hat{\delta}_r - 1}{\hat{\sigma}_{\delta r}} \). Here the ADF statistic is computed for the asymmetric interval \([r_0,1]\). In most applications, our \( r_0 \) will be set to start with a sample fraction of reasonable size. However, there is one limitation of the SADF test is that the starting point is fixed as the first observation of the sample. This implies that in the presence of two bubbles, the second bubble may not be detected if it is dominated by the first bubble. Therefore, Phillips et al. (2011) also apply a rolling version of the SADF test, where the starting window moves over the sample. However, the size of the starting window is still fixed, which limits the power of the test. Phillips et al. (2013) have suggested employing the ‘generalised’ supADF (GSADF) test as a dating mechanism. The GSADF diagnostic is also based on the idea of sequential right-tailed ADF tests, but the diagnostic extends the sample sequence to a more flexible range. Instead of fixing the starting point of the sample, the GSADF test changes the starting point and ending point of the sample over a feasible range of windows. Phillips et al. (2013) demonstrate that the moving sample GSADF diagnostic outperforms the SADF test based on an expanding sample size in detecting explosive behaviour in multiple bubble episodes and seldom gives false alarms, even in relatively modest sample sizes. The reason is that the GSADF test covers more subsamples of the data. The generalized SADF test (GSADF) is able to detect
potential multiple bubbles in the data and thus overcomes the weakness of the SADF test:

$$GSADF(r_0) = \sup_{r \in [0, 1], \tau \in [0, n-1]} \{ ADF^2_{\eta} \}$$

(9)

For further details about both SADF and GSADF tests, interested readers can refer to Philips and Yu (2011), Philips et al. (2011), and Philips et al. (2013).

III. Data

In this paper use the monthly stock price and dividend from the BRICS for our empirical study. The data is obtained from Global Financial Database (GFD). Due to data availability, we have different starting periods for each country. Brazil starts from 1990M1, Russia starts from 1997.9, India starts from 1990.7, China starts from 1995.1, and South Africa starts from 1995.6. All the countries end at 2013.2. We use an initial window size of 36 to start off the recursive estimation. Following the study of Philips et al. (2013), we also use stock price-dividend ratio for our analysis. If we look at the top panel of Figs 1-5, we can see the plots of stock price-dividend ratio for the BRICS stock markets and there might be evidence of multiple bubbles in all five data series. These results motive us to empirically investigate whether there are multiple bubbles in the BRICS stock markets using the test SADF and GSADF tests proposed by Philips et al. (2011a) and Philips et al. (2013), respectively.

IV. Empirical Results and Policy Implications

Tables 1-5 report the empirical results for both SADF and GSADF tests. We find that the null hypothesis of no bubble is rejected for both SADF and GSADF tests for the
BRICS with the exception of SADF tests for Russia, India, and China.\textsuperscript{2} Phillips \textit{et al.} (2013) demonstrate that the moving sample GSADF diagnostic outperforms the SADF test based on an expanding sample size in detecting explosive behaviour in multiple bubble episodes and seldom gives false alarms, even in relatively modest sample sizes. The reason is that the GSADF test covers more subsamples of the data. Based on this argument, we can conclude that there is evidence of multiple bubbles in the BRICS stock markets.

To locate specific bubble periods, we compare the backward SADF statistic sequence with the 95\% SADF critical value sequence, which were obtained from Monte Carlo simulations with 2,000 replications. Fig. 1-5 displays results for the date-stamping strategy over the period for each of the BRICS countries. We can see that there is evidence of bubble during the subprime crisis period for all the BRICS countries. If we look at the Fig 1, there is evidence of another bubble which occurred in the early period of our sample size, specifically during 1992-1994 for the Brazilian stock market. The presence of a bubble around this period may be partly explained by the immediate after effect of the first stock market liberalization in Brazil which took off in May 1991 (Arouri \textit{et al.}, 2010). Fig 2 indicates that there is evidence of another bubble during the middle of 2005 for Russia. During 2005 the Russian stock rose by 83 percent and by the first two months of 2006, it gained 30.5 percent a record rise compared to other world markets over the same period and this was attributed to the influx of foreign pension funds and Russian oil revenues (Daily News, 2006).

For India, there is another short bubble during the end of 1999 period. This

\textsuperscript{2} Recall that nonlinear cointegration test detected a long-run relationship between dividends and stock prices for BRICS, and hence, suggested that there exist no rational bubbles in the equity markets of these countries. We believe that this result is because of the fact that ADL threshold test of cointegration allows for only one regime change, and is likely to have low power just like the SADF test, when in fact multiple bubbles exist over the sample.
bubble is likely due to the spillover of the 1997-2000 dot-com bubble. During this period, the technology industry began embracing the entire world and India’s stock markets started showing signs of hyper-activity. Moreover, it coincided with the period when Ketan Parekh, a former stockbroker based in Mumbai was accused of being involved in engineering the technology stocks scam in India’s stock market in 1999-2001 (FLAME, 2011). Regarding China, we find that there is evidence of 2 bubbles during 2007-2008 subprime crisis periods. The additional bubbles detected could be due to the Chinese stock market bubble in 2007 when the SSE Composite Index of the Shanghai Stock Exchange tumbled 9% from unexpected selloffs, the largest drop in 10 years, triggering major drops in worldwide stock markets (Wikipedia, 2014). Yao and Luo (2009) view the economic psychological factors of “greed” “envy”, and “speculation” as inflating the Chinese stock market bubble, and “fear”, “lack of confidence”, and “disappointment” as an explanation for its bursting. Finally, for South Africa, if we look at Fig 5, there is evidence of another bubble occurred during 2005-2006 period. The 2005-2006 bubble component in South Africa can be attributed to the influx of investors into South African assets (especially equities), which bid up their prices, not only in the form of higher rand prices of equities but also in the form of an appreciation of the currency (Frankel et al., 2006). Overall, our results indicate that multiple bubbles did exist in the BRICS countries.

The existence of bubbles has some implications on the economy. The effects of bubbles can vary depending on different factors and the outcome might be distinct as well for every single agent. Bubbles can harm an economy, but it may simply generate a strong temporary deviation from a price tendency, or it could even benefit the economy (Jiménez, 2011). However, there is empirical clear evidence that every single bubble generates a redistribution of wealth, directly or indirectly, among the various agents in the economy. Tirole (1985) is one of the first researchers who test
the impact of economic bubbles on modeled economies. Later on, Grossman and Yanagawa (1992) expanded Tirole’s model to include economies that grow in the long run at an endogenous rate. The conclusions are that “bubbles retard the growth of the economy, perhaps even in the long run, and reduce the welfare of all generations born after the bubble appears.” The fact that bubbles attract capitals, that otherwise would have been allocated in more productive assets provides support for these theories. Moreover, (Jiménez, 2011) noted that in these models, bubbles can only exist on non-accumulable useless assets and the impact of both the emergence and the burst of the bubble, although might be beneficiary for the current generation, have serious retards on economic growth for future generations. Bubbles might lead to economic distortions as well as financial and real economy instability, and have effects on current output growth, aggregate spending and expected inflation (Roubini, 2006a). The negative impacts of asset price booms and bursts on the economy have also been shown in a number of studies (Bordo and Jeanne, 2002; Borio and Lowe, 2002; Helbling and Bayouni, 2003).

The monetary and fiscal policy authorities in the BRICS economies can learn some lessons from the negative impacts of the .com and the securitization bubbles especially on the middle class. These bubbles generated a clear redistribution of wealth from the middle class—which ended increasing its debts by almost 50% on average- towards the ruling-elites, generated an almost immediate unemployment of 10% on average, implied a bailout of more than $800 Billions just in the U.S, more than doubled the national debt, and plunged world western economies into severe recessions (Jiménez, 2011) that is still been somewhat experienced today. Roubini (2006b) states “monetary policy should react to asset prices and should try to “prick” or “burst” asset bubbles. Bubbles that are growing excessively large lead to economic and investment distortions that are dangerous and likely to eventually trigger bubble
bursts whose real and financial consequences are severe. Thus, optimal monetary policy should preemptively deal with asset bubbles rather than just mop up the mess that they cause after they burst.” Roubini advocates that “asset prices should enter directly in the reaction function of the optimizing monetary authority, above and beyond the direct effects that such asset prices have on expected inflation and current growth.” This view was also shared in Roubini (2006a). Further, Filardo (2002, 2001) theoretically demonstrates that even under uncertainty, optimal monetary policy should react to asset prices. React to the overall asset price, regardless if there is uncertainty about a bubble component or not. Moreover, the need for adopting fiscal policy rules that secure a sound medium-term orientation of fiscal policies while leaving adequate short-term flexibility had been advocated by Jaeger and Schuknecht (2004). However, Jaeger and Schuknecht (2004) noted that the success of such fiscal policy rules hinges largely on the credibly containing expenditure growth and preventing tax cuts during the “high temptation phases” toward the end of a prolonged boom and at the onset of bust phases in asset prices.

Following these arguments and unlike some pro-non-intervention authors (Greenspan, 2004; Bernanke 2002, 2004; Kohn 2004; Blinder and Reis 2005) who argue that uncertainty about a bubble’s existence precludes any policy response, we are of the opinion that both monetary and fiscal policies are relevant for curtailing stock price bubbles given that our study is able to detect the presence of multiple bubbles. However, caution needs to be taken when implementing such policies to avoid a longer lasting negative impact on the economy.

V. Conclusions
This study investigates whether there exist multiple bubbles in the BRICS stock markets using a new test proposed by Philips et al. (2013). Our empirical results
indicate that there did exist multiple bubbles in the BRICS countries, which is not shown in previous studies. Stock prices bubbles can have positive, negative, or zero sum effects. However, empirical evidence show that bubbles generate a redistribution of wealth and can have negative financial and real consequences. Therefore, some expansionary monetary and fiscal policies are required in the BRICS context since these are the most efficient and effective under a bubble burst scenario.

References


Crowder, W. J. and M. E. Wohar (1998), Stock price effects of permanent and transitory shocks Economic Inquiry, 36, 540-552.


Table 1 The SADF test and the GSADF test - Brazil

<table>
<thead>
<tr>
<th>S&amp;P500 Price-Dividend Ratio</th>
<th>SADF</th>
<th>GSADF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27.781***</td>
<td>27.781***</td>
</tr>
</tbody>
</table>

Finite sample critical values

90%   1.393  1.796
95%   1.770  1.993
99%   2.205  2.508

Note: Critical values of both tests are obtained from Monte Carlo simulation with 2000 replications (sample size 278 - (1990.1 - 2013.2)). The smallest window has 36 observations.

Table 2 The SADF test and the GSADF test - Russia

<table>
<thead>
<tr>
<th>S&amp;P500 Price-Dividend Ratio</th>
<th>SADF</th>
<th>GSADF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.676</td>
<td>2.829***</td>
</tr>
</tbody>
</table>

Finite sample critical values

90%   0.719  1.717
95%   1.008  1.857
99%   1.169  2.585

Note: Critical values of both tests are obtained from Monte Carlo simulation with 2000 replications (sample size 186 – (1997.9 - 2013.2)). The smallest window has 36 observations.

Table 3 The SADF test and the GSADF test - India

<table>
<thead>
<tr>
<th>S&amp;P500 Price-Dividend Ratio</th>
<th>SADF</th>
<th>GSADF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.392</td>
<td>2.283**</td>
</tr>
</tbody>
</table>

Finite sample critical values

90%   1.243  2.027
95%   1.483  2.220
99%   1.871  2.404

Note: Critical values of both tests are obtained from Monte Carlo simulation with 2000 replications (sample size 272 – (1990.7-2013.2)). The smallest window has 36 observations.
Table 4 The SADF test and the GSADF test - China

<table>
<thead>
<tr>
<th>S&amp;P500 Price-Dividend Ratio</th>
<th>SADF</th>
<th>GSADF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.351</td>
<td>4.433***</td>
</tr>
</tbody>
</table>

Finite sample critical values

| 90%  | 1.258 | 1.615 |
| 95%  | 1.565 | 1.756 |
| 99%  | 2.081 | 2.080 |

Note: Critical values of both tests are obtained from Monte Carlo simulation with 2000 replications (sample size 218 – (1995.1 - 2013.2)). The smallest window has 36 observations.

Table 5 The SADF test and the GSADF test – South Africa

<table>
<thead>
<tr>
<th>S&amp;P500 Price-Dividend Ratio</th>
<th>SADF</th>
<th>GSADF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.526***</td>
<td>2.588***</td>
</tr>
</tbody>
</table>

Finite sample critical values

| 90%  | 1.021 | 1.750 |
| 95%  | 1.452 | 1.861 |
| 99%  | 1.702 | 2.135 |

Note: Critical values of both tests are obtained from Monte Carlo simulation with 2000 replications (sample size 213 – (1995.6 – 2013.2)). The smallest window has 36 observations.
Fig. 1: Date-stamping bubble periods in the Brazil price-dividend ratio: the GSADF test.

Fig. 2: Date-stamping bubble periods in the Russia price-dividend ratio: the GSADF test.
Fig. 3: Date-stamping bubble periods in the India price-dividend ratio: the GSADF test.

Fig. 4: Date-stamping bubble periods in the China price-dividend ratio: the GSADF test.
Fig. 5: Date-stamping bubble periods in South Africa price-dividend ratio: the GSADF test.