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MONETARY POLICY EXPLOSIVE BEHAVIOR AND PREDICTIONS OF THE SAUDI STOCK MARKET BUBBLES

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Abstract

This paper applies the SADF and GSADF tests' developed by Phillips et al. (2011, 2013) to detect and locate data-stamping of explosive behavior in the Saudi monetary policy. The data includes money supply, bank credit to private sector and interest rates. The results provide strong evidence of the existence of explosive deviations in all three variables. The study, then, attempts to indirectly connect the relevant monetary variables to the existing periodically collapsing Saudi stock market bubbles. The empirical findings support the existence of synchronized behavior between money supply and bank credits that plays a significant role in fueling and accelerating the Saudi stock market bubble of 2006.

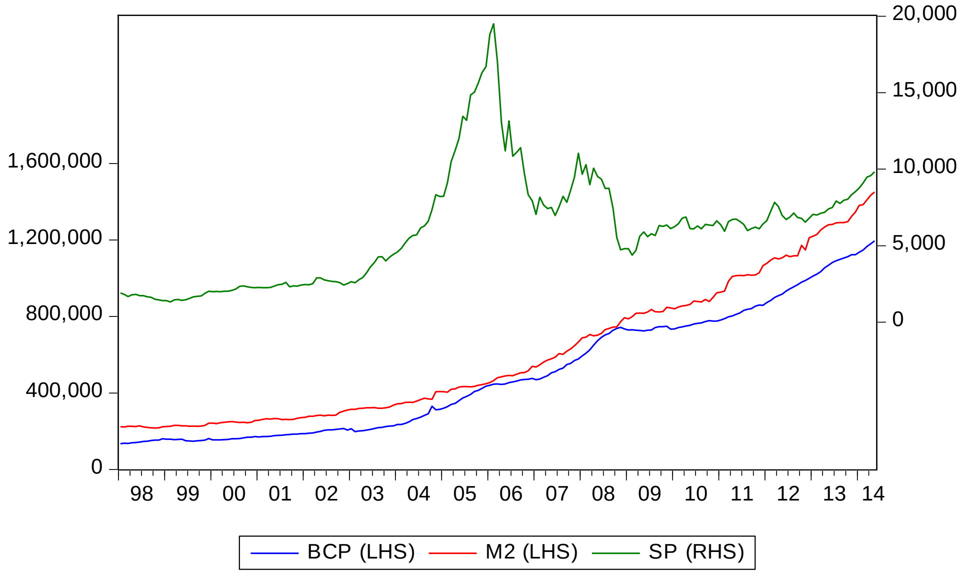
Keywords: SADF, TASI, Bubble, 0Explosive Behavior, Monetary Policy, Saudi

INTRODUCTION

The main objective of this paper is to detect and locate the origination and termination points of the mildly explosive behavior in the Saudi monetary policy and to identify the channels through which this policy could generate date-stamping historical episodes of exuberance and subsequent periodically collapsing stock market bubbles. To do so, the study utilizes a novel procedure of right tail augmented Dickey-Fuller tests, namely the sub ADF test (SADF) and the Generalized version (GSADF) proposed by Phillips et al. (2011,2013), or PWY(2011) and PSY (2013) hereafter.

The sample period lasts from 1998:01 to 2014:05, a period in which the Saudi stock market (TASI) has witnessed an extraordinary expansion. During this period, the largest bubble in the history of the market was formed especially when the market inflated continuously from the beginning of 2004 to February 2006. This period, also, witnessed the burst of the bubble when the market crashed and the index moved down from the highest point in 25th of February 2006 (TASI was 20,634 points) to enter a bearish channel that bulled the index to the level of 4,424 points in October 2008 forcing the market to drop almost 80% of its value. Before such irrational exuberance, Saudi economy witnessed remarkable developments in monetary policy represented by a rapid growth in money supply and bank credit to private sector (figure 1).

Figure 1: Money Supply (M2), Bank Credits (BCP), and TASI (SP)



Thus, it might be a good motive to believe that such an overly expansionary policy stance would have fueled stock speculation and could be seen as early signs of building-up the coming bubbles. Furthermore, it would be interesting to investigate how efficiently the central bank reacted towards the bubble formation and the aftermath of the market collapse. Theoretically speaking, monetary policy can influence stock market through altering the discount rate or by influencing the optimism level of market participants and changing their expectation of future economic activity.

In this study, I recognize the challenge of two important issues: linking monetary policy to financial markets and defining explosive behavior in monetary policy. With regards to the first issue, it is believed that such linkage was a subject of disagreement and controversy among economists. There are those who believe that there is a relationship between the growth of money supply and the increase of stock market returns through what so-called "the wealth effect". That is, increasing money supply may stimulate the private sector activities and therefore increase corporate earnings and dividends, and presumably leading to higher market returns. It is well known that the stock market is connected to the money market through the creation of money supply (liquidity) and the associated interest rate level. With expansionary policy, the market participants will be exposed to a higher liquidity level comes from cheaper loans which may increase speculative atmosphere and causes a market bubble. On the other hand, some economists think that there is no obvious causality between the two variables, particularly because stock markets, especially the efficient ones, have the ability to absorb any current or future changes in money supply and neutralize the impact of this “public news” on the market. The second issue is defining the explosive behavior in monetary policy. Most of previous studies, that utilize similar econometric technique, refer explosive term to stock market bubbles which occur when there are persistent stock price deviations for its fundamental values. However, such definition is hard to apply to monetary variables which do not share a wide area of common fundamentals with the stock market. Therefore, this study will recognize explosive behavior as a variable deviate from unit-root stationarity in an explosive manner. By doing so, we can capture the statistical property of the econometric model without going into details of complex exuberance behavior of stock market.

This research is important because it investigates the existence of a mildly monetary explosive in an economy with distinguished characteristics, such as the Saudi economy. Saudi Arabia is a major oil-exporting country and it has monetary policy with fixed exchange rate regime. Such area is rarely touched on by previous studies which were limited mostly to oil-importing economies. As a matter of fact, the Saudi central bank (SAMA) adopts the fixed exchange rate policy and pegged its currency to the US Dollar. Therefore, it becomes hard for the central bank to adopt independent monetary policy from the anchor country. The main objective for the central bank will be to defend the peg credibility and thus it will have difficulty to deal with domestic activities without jeopardizing the exchange rate peg. Despite passive policy, SAMA has some relatively effective tools to fine-tune domestic monetary stance. SAMA can alter the *discount rate* and indirectly restrict or loosen bank credit conations (Ramady, p.84). SAMA, also, can adjust the level of *reserve requirements* to influence banks’ deposits. Accordingly, this study chooses three variables: money supply; interest rates; and bank credits as the best candidate variable that can measure the effectiveness of monetary policy and its influence on domestic economic activity especially the stock market.

It is expected that the outcomes of this research would elucidate the channels through which monetary policy actions could leak to the movement of stock markets. Knowing such channels would be insightful for policymakers to measure the extent of the impact of their policy changes on the stock market dynamics. Also, the results may be useful for portfolio managers and market participants to quantify the relative importance of public news, such as money supply, on the stock index movements in order to make more successful investment decisions.

Needless to say, detecting a pattern of synchronized explosive behavior in monetary policy can be used as an early sign of the future market bubble.

LITERATURE REVIEW

Many research papers have employed the methodology of Phillips et al. (2011) and Phillips et al. (2013) to directly examine the explosive behavior of asset bubbles. These studies utilized the PWY and PSY techniques to detect and locate the origination and termination points of periodically collapsing bubbles that associated with the stock markets. Other studies have applied such techniques to examine the bubble behavior in other financial prices such as house price index and crude oil prices. For example, Caspi et al. (2014) applies the GSADF test procedure to examine the time-stamping periods of oil price explosive behavior for the period 1876-2014. The study finds evidence of multiple periods of expolisvity in both the real price and the price-supply ratio of oil.

It seems that the above-mention right-tailed approaches can be utilized to examine the explosive behavior in other economic series that not necessarily related to asset market. In this regards, Arora et al. (2011) investigates the existence of large deviation in headline measures of the price level relative to core measures using the GSADF approach. They find that there have been three episodes of explosive behavior in the headline price index of personal consumption expenditure (PCE) relative to core PCE.

Hall et al. (1999) apply relevant and yet different approach to test the presence of a stochastic bubble in a variable when the bubble is periodically collapsing. They use a Markov-switching unit root test to examine the integration properties of money supply, consumer prices, and exchange rate in Argentina for the period 1983:01-1989:11. The main objective is to investigate when non-stationarity consumer prices could be due to explosive rational bubbles. The study concludes that explosive behavior is not present in either money supply or exchange rate variables, but it provides evidence of the existence of a rational bubble in consumer prices.

This study takes the approach of PWY and PSY to another different dimension by examining periods of mildly explosive episodes of Saudi monetary policy and then connects the findings to the Saudi stock market bubbles.

METHODOLOGY

Econometric Approach

This paper utilizes two related methods that depend on Augmented Dickey-Fuller (ADF) test. These tests are sup ADF (SADF) and generalized sup ADF (GSADF). While the first test is capable of detecting the existence of bubbles, the second test are designed to date-stamp their occurrences. The null hypothesis, in this type of tests, is a unit root process against the alternative of a mildly explosive deviation. Technically speaking, the strategy of detecting explosive behavior is introduced and developed in Phillips, Wu and Yu (2011, hereafter PWY) and Phillips, Shi and Yu (2013, hereafter PSY). The procedure recognizes explosiveness when data exceed predetermined critical values of right tail ADF. Therefore, PSY assume the following random walk process for $y_t$with asymptotically negligible intercept (drift):

$$y_t = dT^{-\eta} + \theta y_{t-1} + \varepsilon_t,\ N(0,\sigma^2),\ \theta = 1 \quad (1)$$

Where d is a constant, T is the sample size, and η is a localizing parameter to control the drift. The model specification (1) is developed to a recursive approach that based on the following reduced form:

$$\Delta y_t = \alpha_{r_1,r_2} + \beta_{r_1,r_2} y_{t-1} + \sum_{i=1}^{k} \psi_{r_1,r_2}^{i} \Delta y_{t-j} + \varepsilon_t \quad (2)$$

The above specification is estimated repeatedly in a rolling window ADF regression. The regression starts from r_1^{th} fraction of the sample size T and ends at the fractional ending point r_2^{th}. The window size of the regression r_w, where $r_w = r_2 - r_1$, starts from a smaller window size r_0 to 1 as the largest window fraction. The ADF test (t-ratio) $ADF_{r_1}^{r_2}$ is computed for these different subsamples. PWY proposed recursive calculation of the ADF statistics to detect explosive behavior. This method, the sup ADF (SADF), implements a right tailed ADF test with fixed starting point $r_1$and the ending point, $r_w = r_2$, varies from r_0 to 1. Thus, the forward sup ADF is defined as:

$$SADF(r_0) = \sup_{r_2 \in [r_0,1]} ADF_0^{r_2} \quad (3)$$

Despite its efficiency of detecting a single periodically collapsing bubble, this test can be inconsistent and its discriminatory power could be reduced when detecting multiple episodes of collapsing bubbles. To overcome such limitation, PSY suggest a generalized version of SADF that is termed GASDF, formally:

$$GSADF(r_0) = \sup_{\substack{r_2 \in [r_0,1] \\ r_1 \in [0, r_2 - r_0]}} \left\{ ADF_{r_1}^{r_2} \right\} \quad (4)$$

This test differs from the previous one by varying the ending point r_2 from $r_0$to 1, and permits the starting point of the regression $r_1$to vary within a feasible range of rolling windows. This flexibility combined with covering more subsamples will allow GSADF to outperform ASDF in detecting multiple explosive behaviors. Under the null hypothesis y_t in regression (1) is a random walk, the asymptotic distribution of GSADF test is:

$$\sup_{\substack{r_2 \in [r_0,1] \\ r_1 \in [0, r_2 - r_0]}} \left\{ \frac{\frac{1}{2} r_w \left[W(r_2)^2 - W(r_1)^2 - r_w \right] - \int_{r_1}^{r_2} W(r)dr \left[W(r_2) - W r_1) \right]}{r_w^{1/2} \left\{ r_w \int_{r_1}^{r_2} w(r)^2 dr - \left[\int_{r_1}^{r_2} W(r) dr \right]^2 \right\}^{1/2}} \right\} \quad (5)$$

where $r_w = r_2 - r_1$and *W* is the standard Wiener process.

Furthermore, PWY suggest the date-stamping strategy which can determine whether any particular real time data provides evidence of explosive patterns within a particular sample. To be more specific, the SADF-based strategy compares each element of ADF_{r_2} to the matching right-tailed critical values and concludes that an observation belongs to an explosive phase or not.

$$\hat{r}_e = \inf_{r_2 \in [r_0, 1]} \left\{ r_2 : ADF_{r_2} > cv_{r_2}^{\beta_{Tr_2}} \right\} \quad (6)$$

$$\hat{r}_f = \inf_{r_2 \in [\hat{r}_e, 1]} \left\{ r_2 : ADF_{r_2} < cv_{r_2}^{\beta_{Tr_2}} \right\} \quad (7)$$

where $cv_{r_2}^{\beta_{Tr_2}}$ is the $100(1-\beta_T)\%$ right-tailed critical value of the standard ADF test obtain by Monte Carlo simulations.

Similarly, the new strategies of the bubble origination and termination points based on GSADF are:

$$\hat{r}_e = \inf_{r_2 \in [r_0, 1]} \left\{ r_2 : BSADF_{r_2}(r_0) > cv_{r_2}^{\beta_{Tr_2}} \right\} \quad (8)$$

$$\hat{r}_f = \inf_{r_2 \in [\hat{r}_e, 1]} \left\{ r_2 : BSADF_{r_2}(r_0) < cv_{r_2}^{\beta_{Tr_2}} \right\} \quad (9)$$

where $cv_{r_2}^{\beta_{Tr_2}}$ is the $100(1-\beta_T)\%$ right-tailed critical value of the sup ADF test with corresponding significance level of β_T.

Finally, the backward sup ADF test (BSADF) of GASDF will be as follows:

$$GSADF(r_0) = \sup_{r_2 \in [r_0, 1]} \left\{ BSADF_{r_2}(r_0) \right\} \quad (10)$$

Thus, the GSADF test is based on repeated implementation of the sup ADF for each $r_2$varying from r_0 to 1.

The Data

This study uses money supply, interest rates and bank lending to private sector to measure the monetary actions. The data series are taken from quarterly bulletin issued by the Saudi Arabian Monetary Agency (SAMA) for the monthly period 1998:01-2014:05. Table (1) exhibits the descriptive statistics for, money supply (M2), bank credits (BCP), U.S. interest rate (USR) and the Saudi stock market index (SP).

For all data, Jarque-Bera tests reject the normality of the conditional distributions. Moreover, all variables show positive values of skewness (skewed to the right) except for market returns which skewed to the left.

Table 1: Descriptive Statistics

	M2	BCP	USR	SP
Mean	603458.1	500453.6	2.668699	0.834849
Median	482631.5	446582.0	1.852000	1.370992
Maximum	1450754.	1195557.	6.698000	17.89515
Minimum	216812.0	136314.0	0.215000	-29.77534
Std. Dev.	359671.2	320773.8	2.209011	7.168606
Skewness	0.680438	0.477464	0.343973	-0.890671
Kurtosis	2.192371	1.899112	1.541295	5.368271
Jarque-Bera	20.45134	17.34471	21.24223	71.71877
Probability	0.000036	0.000171	0.000024	0.000000
Observations	196	196	196	196

ANALYSIS AND EMPIRICAL RESULTS

This section presents empirical testing results for explosive behavior in the above-mentioned variables. Statistical interpretation of explosiveness refers to a variable whose regression equation has roots within the unit circle which implies testing the null hypothesis of a unit root against the alternative of explosive manner. Technically speaking, I tend to compare the finite sample critical values to the corresponding asymptotic critical values. The explosive behavior would exist if and only if the finite sample critical values are greater than those of the corresponding asymptotic critical values. The simulation procedure involves determining the window size at length *T* in equation (1); estimating the equation (2) using OLS regression and save the relevant test statistics; repeating the first step *N* times; and calculating the asymptotic distribution critical values. In this study, the minimum widow size is 2 representing 2% of the sample size of 197 observations and the critical values are obtained by using Monte Carlo simulations with 1,000 replications. The lag length is set to four due to the lags associated with monetary action in response to stock market fluctuations; and the parameters d, θ and η in equation (1) are set to unity.

The simulation process indirectly connects the relevant monetary variables to the existing periodically collapsing stock markets bubbles. The process involves detecting the starting and ending points of explosive periods for money supply, interest rates and bank loans. Money supply is picked to reflect the direct monetary policy; while interest rate represents the indirect monetary policy imposed by the adaptation fixed exchange rate regime. The last variable, bank loans, is the optimal candidate to measure the effects of monetary actions on private sector dynamics through altering the discount rate and banks' reserves.

The study begins by considering SADF tests. This test is capable of detecting the occurrences of explosive behavior in these variables. Critical values of the SADF tests are shown in table (2) along with the respective finite sample critical values are presented in table (2).

Table 2: SADF Test and Critical Values

Panel A:		
Variables	**SADF t-Statistics**	**Prob.**
Money Supply (M2)	2.369088	0.0000
Bank Credits (BCP)	4.252298	0.0000
U.S. Interest Rate (USR)	2.504392	0.0010
Saudi Stock Index (SP)	7.050329	0.0000
Panel B:		
Test Critical Values		
99% level		1.155483
95% level		0.516003
90% level		0.244079

The numeric simulations are obtained from 1,000 Monte Carlo replications. With regards to money supply, the date-stamping strategy provides evidence of explosive behavior as the simulated SADF *t*-statistics reaches 2.369, which is greater than the corresponding (right tail) 99% critical values as seen in the top panel of table (2). To visually locate the bubble in money supply, figure 2 shows the starting and ending points of the explosive periods. Clearly, there are two long-lasting bubbles: the first one starts in November, 2004 and ends in August of 2005; while the second bubble begins in February 2006 until August 2009. However, the GADF test has less accuracy results with smaller bubble period as seen in figure 3.

Figure 2: SADF Test for Money Supply (M2)

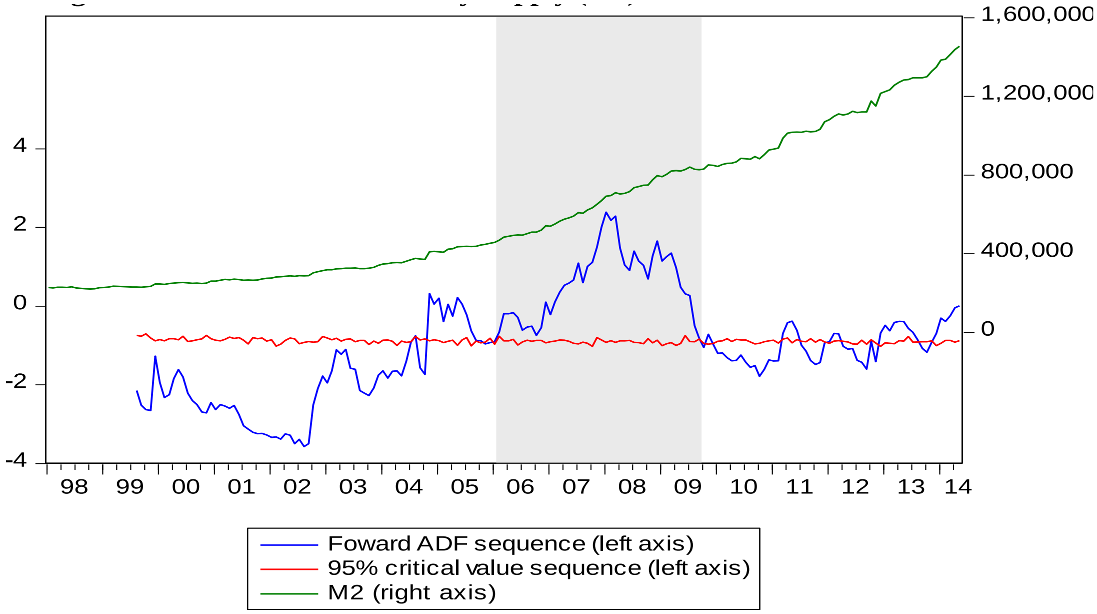
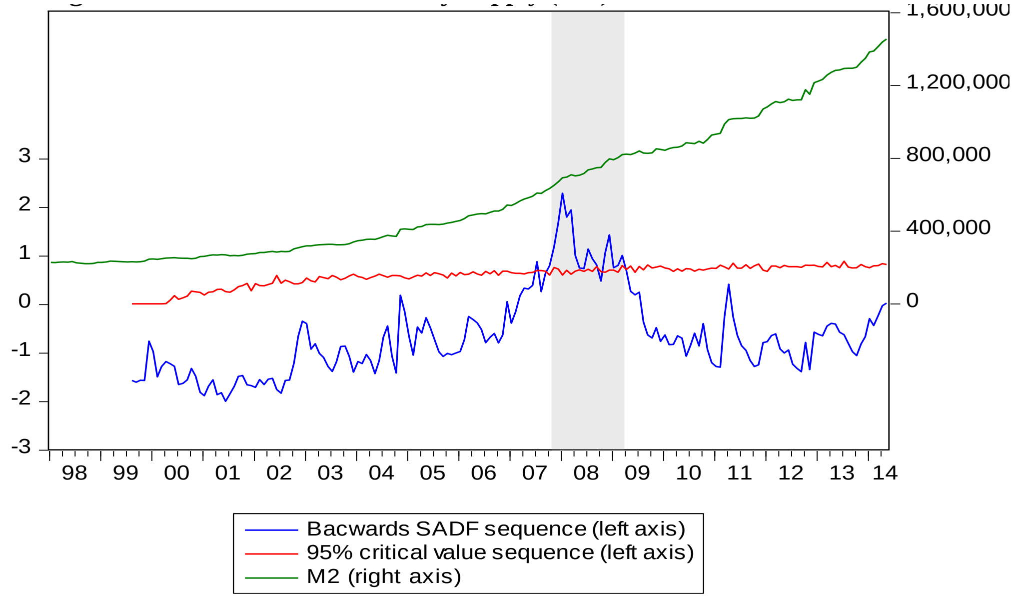
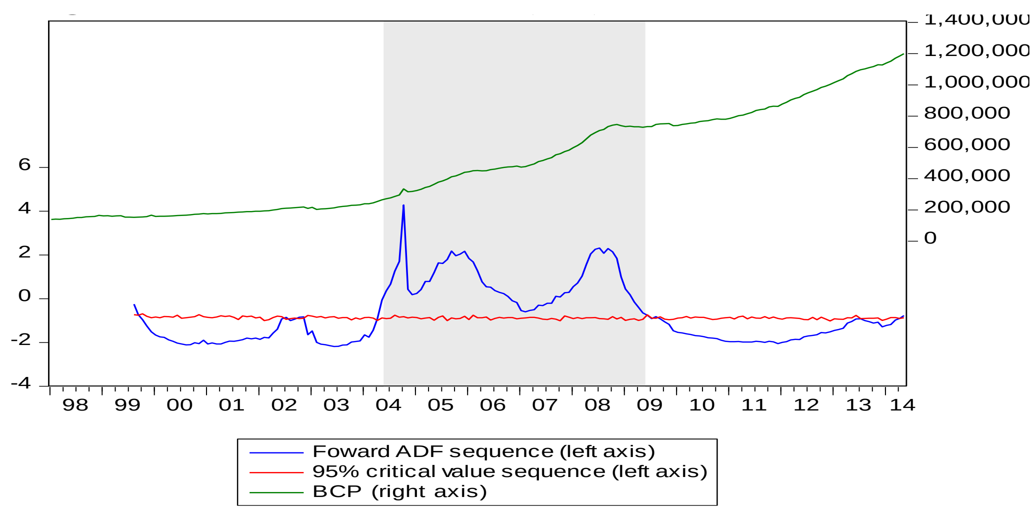


Figure 3: GSADF Test for Money Supply (M2)



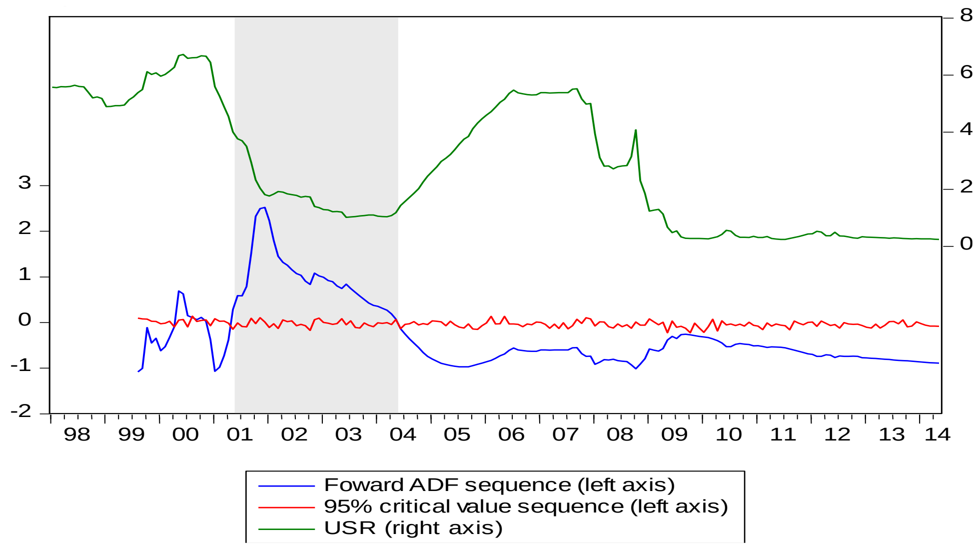
By the same token, bank credit to private sector exhibits an explosive behavior since the SADF statistics is 4.252, which is greater than the 99% critical value 1.155 (table 2). Figure 4 plots the backward SADF statistics for bank loans where the identified periods of exuberance and collapse periods are marked by the shaded areas. This variable shows long-lasting bubble that starts in May 2004 and continues to the same month in 2009 (figure 4).

Figure 4: SADF Test for Bank Credits (BCP)



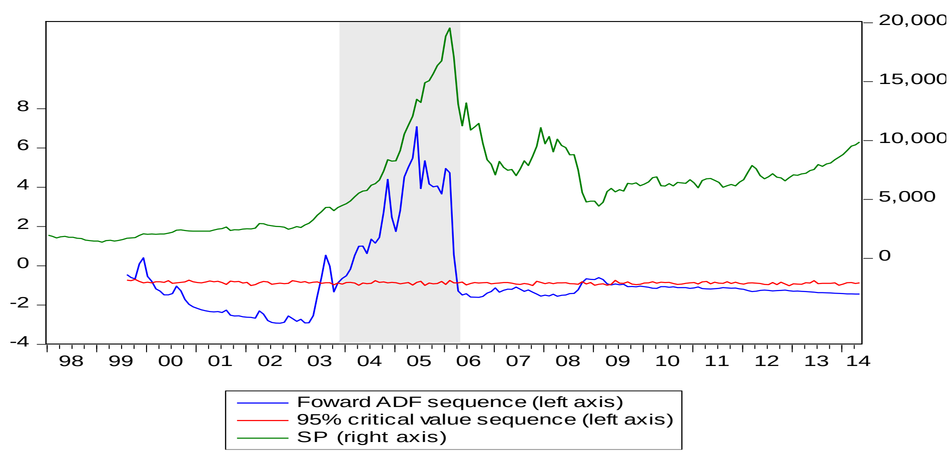
Last but not least, US interest rate has shown a clear sign of explosive behavior with 2.504 t-statistics for the SADF test as seen in table 2. However, figure 5 provides a visual location of the bubble which begins earlier, compared to the other variables, in May 2001 and lasts until May 2004.

Figure 5: SADF Test for US Interest Rate (USR)



Now, it is essential to determine whether these monetary variables can be seen as significant warning signs for stock market bubble. To do so, I conduct SADF test for Saudi stock market index (TASI). The empirical results strongly confirm the existence of explosive behavior since t-statistics for SADF is 7.05 compared to the 99% critical value 1.15 as shown in table 2. The test, also, detects the initiation and termination of the bubble which starts in February 2004 and ends up in April 2006 (figure 6).

Figure 6: SADF Test for the Saudi Stock Market Index (SP)



Connecting figure 6 to figures 2-5 provides some interesting findings. The explosive behavior of money supply and bank credit to private sector are highly coincided with the occurrence and growth of TASI bubble. This implies that monetary policy follows a conservative strategy towards the possible asset price bubble. In such a passive strategy, policymakers tend to follow pro-cyclical policy in response to market movements, assuming that the market will be eventually driven by rationality and fundamentals. Therefore, the empirical evidence supports the fact that monetary policy does not initiate the stock market bubble, but it obviously participates in fueling and accelerating the market boom.

CONCLUSION

This paper has examined the possibility of detecting a pattern of synchronized explosive behavior in monetary variables that can be used to forecast the future stock market bubbles. Unlike standard unit root tests, the study applies SADF and GSADF approaches which are more powerful to recognize variables that deviate from unit root stationarity in an explosive manner. Technically speaking, the process involves accurately determining the origination and termination of explosive periods in monetary variables and then connects them to the periodically collapsing bubbles of the Saudi stock market. The study finds that the explosive deviations of money supply and bank credit are highly coincided with the major collapsing stock market bubble of 2006.

The study suggests that such monetary variables can be used as a forecasting power during explosive periods of the stock market, but not as an early sign of a coming bubble. Having said so, it is important to emphasize that following pro-cyclical (expansionary) monetary policy in response to stock marker rising would fuel and accelerate the market boom and eventually may create a market bubble. The study can be expanded geographically to include heterogeneous groups i.e., GCC countries which may provide more insights on the subject.

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