Testing for Exuberance Behavior in Agricultural Commodities of Pakistan

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Abstract

One of the basic aims of the sustainable development goals is to reduce poverty, hunger and malnutrition across the globe. It is believed that commodity booms have severe impacts on developing countries where households spend large share of their disposable income on food. Thus, hitting the poor's ability buy necessities such as food and energy. Pakistan being a developing economy has a large share of its exports that depends on the agriculture sector in which price is the main determinant and plays a key role. In last decade, an increasing trend has been observed in agricultural commodity prices leading to food insecurity, poverty and inflation in the economy. Thus, it is essential to figure out the price bubbles in the agriculture sector. In this regard, present study is preliminary in nature and takes a lead in addressing this important issue and finds out the bubbles in agricultural commodity prices of Pakistan. The empirical analysis is carried out by employing recently developed state of art GSADF approach developed by Phillips et al. (2015) and making use of monthly data of seven key agricultural commodities in Pakistan spanning over the period of 18 years (2000M1 to 2018M5). The findings suggest the occurrence of bubbles in all price series with some interesting facts. Some relevant policy recommendations are discussed as well.

Key Words: Multiple Bubbles; GSADF; Monte-Carlo Simulations; Unit Root

JEL Classification Code: Q14; Q18

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1. Introduction

This paper examines that formation of bubbles episodes in food and agricultural commodity prices and identifies the origin and collapse of bubbles (if any). Over the last decade, commodity markets have experienced a drastic price fluctuation and from a herding and speculation perspective, food commodities are considered as a profitable investment in comparison with alternative assets due to its direct association with food security (Mcphail et al. 2014). Excessive price hikes and bubbles in food prices may not only cause a huge shock in domestic markets but create a political turmoil in global markets owing to its adverse and negative welfare implications among market entities (Bekkers et al., 2017). Furthermore, it may intensify poverty and trigger political turbulence, particularly in countries where large share of household budget is constituting towards food commodities (Sanders and Irwin, 2010; Algieri, 2014). Subsequently, food price bubbles have become an intensive debate and global concern.

In the debate of expected reasons behind the phenomena of bubble formation, some argued that speculation is the main driving force that causes prices to change abruptly, whereas the proponents of speculation argue that it plays a counterpart in hedging activities and provides liquidity to most illiquid markets and, in addition, it has stabilizing effects on prices (Gilbert, 2010; Sanders & Irwin, 2010). Rausser (1985) examines that macroeconomic forward and backward linkages are the causal factors that lead to sudden booms in commodity prices, suggesting that the global increase in agricultural commodities prices in 1973-74 is largely caused by the money markets performance and foreign exchange rate markets fundaments. The most crucial bubble occurs in the year 2008 (known as silent Tsunami) where almost all agricultural commodity prices were exotic and then the bubble bursts and then it ascends again in 2011 (Carter et al., 2011; Adammer & Bohl, 2015). These highly elevated food prices have prompted an exhaustive argument to figure out the origins and reasons of this price boom. As it has hazardous impacts on economy in terms of high inflation, recession, income distribution and poverty (FAO, 2008; von-Braun, 2008).

It has raised several important questions that why bubbles formed and what factors and conditions led to price bubbles? However, in most cases, it is a difficult task to know these reasons due to data constraints (Li et al., 2015). Numerous studies are available on the bubble detection in agricultural commodities by making use of data of different countries with a claim of single and/or multiple bubbles (see e.g., Areal et al., 2014; Diesteldorf et al., 2016; Spavound & Pavlidis (2016); Ma et al. (2015); Alexakis et al. (2017); Wang et al. (2018); among many others). However, on this aspect, to the best of our knowledge, no study is available on this issue for Pakistan. The present study takes a lead and critically analyzes the existence of bubbles in the major agricultural commodity prices beginning from Jan 2000 to May 2018. The empirical analysis is based on monthly time series data from Jan 2000 to May 2018 and analysis is performed by employing recently developed state of art—the Generalized Supremum Augmented Dickey Fuller (GSADF) approach, proposed by Phillips et al. (2015). Some important policy implications are discussed as well.

Rest of the paper is organized as follows:

Section 2 provides detailed review of relevant literature on the subject while section 3 discusses theoretical framework. Section 4 discusses econometric methodology along with the data and its sources followed by a section on empirical results. Finally, last section provides conclusion and relevant policy recommendations.

2. Literature review

Several studies have been done for Pakistan, but they cover only the issues such as food security with the focus on the availability, accessibility and utilization of food. Hussain & Routray (2012) calculate the level of food self-sufficiency in all provinces of Pakistan using annual time series data starting from 2000 to 2009, suggesting that food is unacquired due to physical, economic and natural factors, while food gap exists owing to inadequate food acquisition and circulation system, illicit transfer of food items, inefficient marketing systems as well as with the reduced purchasing power and unexpected natural disasters.

Rehman & Khan (2015) basing their analysis on annual time series data from 1990 to 2013 and relying on time series methods such as vector error correction model and the johansen cointegration test, find that government support and GDP are found to be inversely linked with food prices and the role of indirect taxes in rising food inflation is substantial.

Khan et al. (2019) estimate an OLS regression and analyze three aspects (availability, accessibility and absorption) of food security in rural areas of Pakistan. The empirical findings suggest that in terms of availability, all the districts except Sindh are expected to be food unassured and electrification as well as adult literacy rate have negative impacts on food accessibility while on food absorption, positive impact is found for child vaccination, safe water consumption and the number of hospitals.

It is important to note that all the existing studies related to agricultural commodities carried out for Pakistan have focused on several issues such as food security with relevant challenges (Zhou et al. (2017); Ali (2017); Khan et al. (2019) among others), other than food price bubble and till date no study exists on the importance and detection of bubble in agricultural commodity prices in context of Pakistan even though it is a burning issue especially after the global food crisis of 2008 in which almost all the food and agricultural product prices become skyrocketed and it effected all the stakeholders. However, for countries other than Pakistan, numerous studies exist that discuss the issue of bubbles and provide empirically evidences on the bubble detection in agricultural commodity prices. See for example, Went et al. (2009); Adammer et al. (2012); Ma et al. (2015); Areal et al. (2016); Alexakis et al. (2017); Wang et al. (2018) among others. Table 1 in Appendix provides summary of existing studies.

Thus, the present study is a pioneer in nature as it takes a lead and addresses this important issue for the key agricultural commodity prices for Pakistan using latest available time series data and by employing recently developed approach by Philips et al. (2015) that can detect multiple bubbles.

3. *Theoretical Framework*

The formation of price bubbles in the commodity sectors is mainly accredited to speculation and chaos of market entities. Regarding this, various relevant theories explain this phenomenon such as *rational commodity pricing theory* and psychological theories include *animal spirit*, *the greater fool theory* & *extrapolation theory* (Jimenez & Vilella, 2011). These psychological theories claim that when the market or economic agents behave irrationally, it causes asset or commodity price distortion and therefore creates instability in the market. However, the foundations of all these psychological theories is traced back with the Keynesians concept of irrationality behavior (Caramugan & Bayacag, 2016).

The most widely used theory in existing literature is rational commodity price theory developed by Pindyck (1993), where present value model is applied on rational commodity prices. In this theory, the commodity price is P_t considered by the present and expected future payments (profit that is earned from the sale of output or commodity) denoted by γ_{t+1}. It is emphasized that, for a storable commodity payoffs or future stream γ_{t+1} is the convenience yield, that accrues inventory owner in the form of benefits which can be earned from sales and stock out avoidance. Convenience yield is defined as resale value of any gains that an inventory provides in terms of facilitation of production, stock falls prevention and scheduling of sales which accrues and grow inventory owner. The general arbitrage condition is

$$P_t = E_t\left[\sum_{i=1}^{T-1} \frac{1}{(1+D)^i}(\gamma_{t+1})\right] + E_t\left[\frac{1}{(1+D)^{T-i}} P_T\right] \qquad [A]$$

Where, D is discount rate.

Price of the commodity at time t is indicated by market fundamental components (demand & supply) or first term, it may diverge from market fundaments as dictated by second term or bubble component. If bubble does not exist then $\lim_{N\to\infty} E_t\left[\frac{(P_{t+N})}{(1+D)^N}\right] = 0$, showing that commodity price is solely reflect the market fundamental dynamics when bubbles does not present then eq. [A] becomes: $P_t^f = \sum_{j=1}^{\infty} \frac{1}{(1+D)^i} E_t\left[\gamma_{t+j}\right]$

This equation is known as transversality condition which means when bubble component is not present price of commodity is solely depends on market fundamentals component. Without imposing a transversality condition, price of commodity at t is simplified as follows:

$$P_t = F_t + B_t$$

Where,

F_t shows fundamental components and B_t shows bubble component or explosive behavior. When $B_t = 0$ then P_t determined through market fundaments F_t and if F_t is integrated of order then then P_t is also an integrated process of order one (Areal et al., 2014).

4. ***Econometric Methodology and Data***

The procedures employed in the present study is based upon the work founded by Philips et al. (2011) and Philips et al. (2013) to test single and multiple bubbles as well as their date stamping. Although previously, standard Augmented Dickey Fuller (ADF) unit root test developed by Dickey & Fuller (1979) is used to test bubbles in empirical research. The major drawback of this test is that it can not detect the periodically collapsing bubble. To cope with this issue, Supremum Augmented Dickey Fuller (SADF) and Generalized Augmented Dickey Fuller (GSADF) suggested by Philips et al. (2011) and Philips et al. (2013) can be used to consistently estimate the collapsing episodes in bubbles. The following regression model is considered.

$$X_t = \rho + \omega X_{t-1} + \sum_{k=1}^{n} \theta_k \, \Delta X_{t-k} + \epsilon_t ----[1]$$

Where X_t represents price of agricultural commodities including (wheat, rice, soybean, sugar, barley, cotton and maize), ρ is intercept, ω is coefficient of first lag of X_t, θ_k is coefficient of ΔX_{t-k} , and ϵ_t is an error at time 't' with mean zero and constant variance.

Our aim is to find out the explosive behavior (detecting bubbles) of price series and it is done by formulating the following null hypothesis: $H0\colon \omega = 1$, against the right tailed alternative: $H1\colon \omega > 1$.

For ease, some notations are being introduced below, first the sample is normalized to convert the sample into a [0,1] interval. Let $ADF_{s1,s2}$ and $\omega_{s1,s2}$ respectively exhibit the ADF statistic corresponding to estimated coefficient of X_{t-1} in above equation [1] over the normalized sample $[S_1, S_2]$.

Further, let W_S be the window size represented by $W_s = S_2 - S_1$. Before explaining SADF & GSADF tests it is good to understand the right tailed version of unit root test. Let S_1 , S_2 be the initial and last observations of selected sample respectively. For instance, window size is $W_s = 1$ that implies the critical values of RTADF will be different from the usual ADF unit root test. The calculated value of RTADF is compared with the corresponding 1%, 5% or 10% critical values and if estimated value is found to be larger than critical value then discard null hypothesis of unit root.

The SADF test builds on ADF statistic with fix starting point and with varying window size. The initial window size is selected by (0.01 + 1.8 $\sqrt{_T}$) proposed by Phillips et al. (2015). The estimation goes as following steps. In the window size estimation, first observation of the sample placed as starting point S_1i.e., S_1= 0 and the endpoint S_2 is set accordance to minimal window size S_0 ,as mentioned above the initial window size is $w_s = s_2$ .Then estimate the regression recursively by augmenting the window size $s_2 \in [s_O , 1]$, one observation at a time and ADF statistic (ADF_{s2})

is calculated for each estimation. However, estimation carried out in the last step is based on entire sample i.e $s_2 = 1$ and the corresponding statistic is ADF_1. The SADF statistic is the supremum value of ADF_{s2} sequence for $s_2 \in [s_O\ , 1]$.

$$SADF_{(so)} = \underbrace{sup}_{s2 \in [s0,1]} \{ADF_{s2}\}$$

The generalized form of SADF is GSADF suggested by PSY (2015) is most widely used due to its flexible window-size. In this procedure initial window size s_2, can also differ inside the given range of [o, s_2 - s_O]

$$GSADF_{(so)} = \underbrace{sup}_{\substack{s2 \in [s0,1] \\ s1 \in [0, s2-s0]}} \{ADF_{s1}^{s2}\}$$

4.1.Date stamping of bubbles

The SADF and GSADF techniques can also be applied for date stamping strategy of bubbles where one can find the origination and termination points of bubbles. One can estimate the bubble period of GSADF procedure as:

$$\widehat{s_e} = \underbrace{inf}_{s2 \in [s0,1]} \left\{s_2 : BSADF_{s2} > Critic_{s2}^{\delta T s2}\right\}$$

$$\widehat{s_f} = \underbrace{inf}_{s2 \in [se,1]} \left\{s_2 : BSADF_{s2} < Critic_{s2}^{\delta T s2}\right\}$$

The critical value of the sup ADF statistic is $Critic_{s2}^{\delta T s2}$ $i.e$ $100\ (1 - \delta_T)\%$ which is based on $[T_{s2}]$ observations. The value of backward sup ADF statistic is $BSADF_{(s0)}$ for $s_2 \in [s_0, 1]$ that can link to GSADF by noting this

$$GSADF_{(so)} = \underbrace{sup}_{s2 \in [s0,1]} \{BSADF_{s2}\}$$

4.2. Data and its Sources

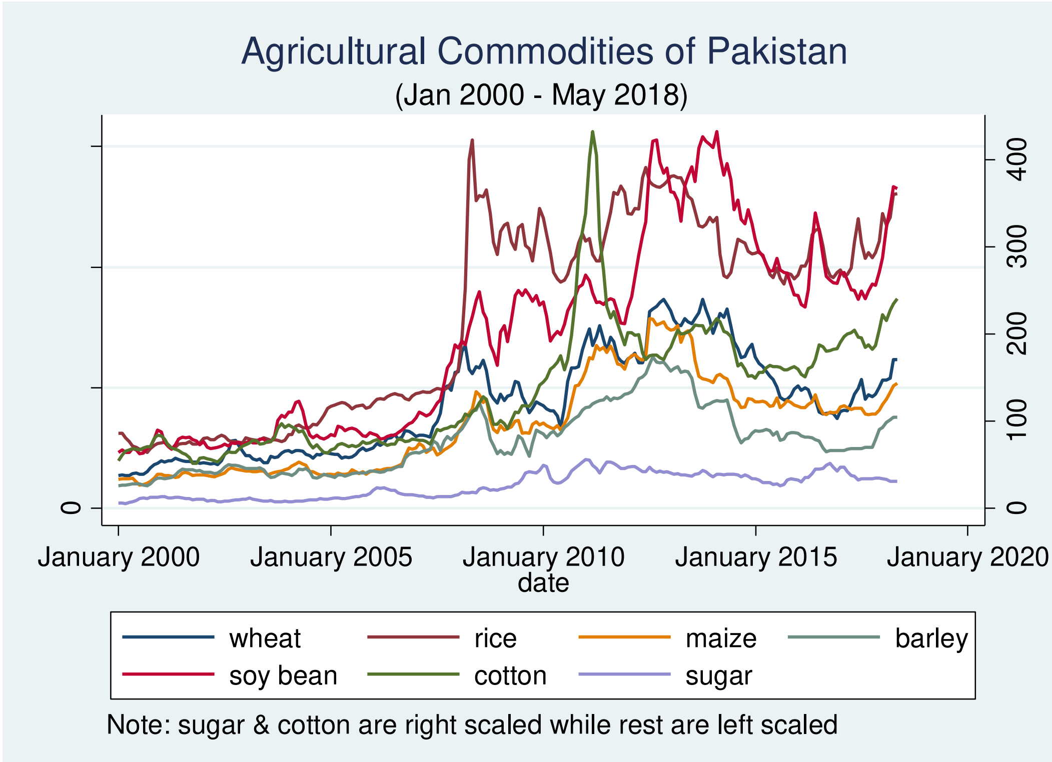
The study uses monthly time series data from Jan 2000 to May 2018 for the prices of key agricultural commodities (wheat, rice, cotton, sugar, maize, barley and soybean). The choice of sample period and crops is made upon the availability of maximum data. Nominal wholesale prices are considered and the type and nature of the selected crops are different with wheat and rice being the major crops and cotton being a cash crop while soybean is a minor crop. Maize and barley are grains while sugar is the processed final product. The purpose of incorporating varying nature of crops in the study is that as wheat is staple food crop and it is directly associated with food security, cotton and rice are the major exports of Pakisan while soybean is not grown at large scale and it is mostly imported from US and India. All the data has been extracted from Index Mundi World Bank. The list of variables along with their measuring units is provided in Table 2 below:

Table 2: Details of Variables with their measurement

S. No.	Variable Name	Measuring Unit
1	Wheat	PKR per Metric Ton
2	Rice	PKR per Metric Ton
3	Sugar	PKR per Kg
4	Cotton	PKR per Kg
5	Maize	PKR per Metric Ton
6	Barley	PKR per Metric Ton
7	Soybean	PKR per Metric Ton

The graphical view showing the general pattern of each of the selected agricultural commodity price series is provided in Figure 1. It is seen that prices are fluctuating and rising in 2008, followed with decline in prices and then started rising again in 2010. This price surge and boom mainly occurred in rice, soybean and cotton price series.

Figure 1:Agricultural Commodities of Pakistan



5. *Empirical Analysis*

The empirical analysis starts with the basic summary statistics of all price series considered (see Table 3 below).

Table 1: Basic Summary Statistics

Variable	Mean	SD	Median	IQR	Min	Max	Skewness	Kurtosis
Wheat	17355.40	8313.65	17351.90	14848.92	5443.88	34665.46	0.35	1.94
Rice	31684.88	16220.05	38645.75	31589.96	9270.69	61146.25	-0.10	1.37
Cotton	134.88	69.54	114.52	109.66	51.37	432.13	1.18	5.09
Maize	13789.98	7585.51	13749.66	11903.37	3898.35	31461.29	0.52	2.24
Barley	11107.46	5394.03	10166.98	8008.45	3787.33	25117.32	0.72	2.68
Soybean	28557.12	15864.36	30472.40	26562.17	9063.52	62475.05	0.36	1.94
Sugar	26.14	14.55	24.12	27.27	5.70	55.74	0.21	1.61

Note: Total number of observations are 221 (Jan 2000 to May 2018) in each price series.

By looking at the basic summary statistics, it can be noted that average and median prices of wheat and maize are close to each other suggesting that these series are symmmetric in nature. On a similar pattern, rice and soybean are left skewed while the rest of the series are skewed to the right. The minimum price of wheat and rice are 5,443.88 and 9270.69 (both measured in PKR per metric ton) in April 2000 and Sep 2000 respectively while the maximum prices of the same series are 34,665.46 and 61146.25 on November 2012 and May 2008 respectively. The value of kurtosis measure shows that the distribution of all variables is platykurtic except cotton which is leptokurtic.

5.1.Bubble Detection Results

The results of GSADF test for each agricultural commodity price series along with date-stamping of bubbles are provided in Tables 4. The finite sample critical values at 1%, 5% and 10% significance level are calculated, for both SADF and GSADF test statistics for the null hypothesis of no bubbles against alternative of explosive behavior, by carrying out 1,000 Monte Carlo simulations and considering zero lag order.

It can be noted that the p-value corresponding to SADF as well as GSADF statistic is zero to the three decimal places for all price series suggesting the rejection of null of no bubble at all three conventional significance levels (1%, 5% and 10%). The same conclusion is drawn based on critical values provided at the bottom of Table 4 which shows that the calculated values of SADF and GSADF statistics are greater than the corresponding critical values (1%, 5% and 10%).

The GSADF test is far better than SADF because it can detect periodically collapsing multiple bubbles (Phillips et al., 2015).

Table 2: Results of SADF and GSADF Tests (Jan 2000 to May 2018)

Commodity	**SADF Statistic**	**GSADF Statistic**
Wheat	4.210^{***} (0.000)	4.262^{***} (0.000)
Rice	4.121^{***} (0.000)	15.944^{***} (0.000)
Cotton	5.843^{***} (0.000)	11.190^{***} (0.000)
Sugar	4.209^{***} (0.000)	5.199^{***} (0.000)
Maize	4.434^{***} (0.000)	5.692^{***} (0.000)
Barley	5.138^{***} (0.000)	3.928^{***} (0.000)
Soybean	4.256^{***} (0.000)	5.835^{***} (0.000)
Critical value	**SADF**	**GSADF**
1%	2.265	2.594

5%	1.485	2.090
10%	1.075	1.876

Note: p-values are provided in parentheses while *** denotes significance at 1% significance level.

Since GSADF is better than SADF by construction as it can detect multiple bubbles, so the results of bubble date-stamping are done for the case of GSADF only. Table 5 provides the results of date stamping of each price series along with start and end period of bubble as well as the duration of bubbles in months to give an idea if a bubble is of short duration or the longer one. From Table 5, it is seen that highest number of bubbles occurred in soybean price series while lesser number of bubbles have occurred in wheat and rice prices.

The analysis presented in Table 5 above is further elaborated graphically in Figure 2 (a—e). The green line indicates price series while red line shows 95% critical value and blue line shows Backwards SADF statistic. It can be observed that the Backwards SADF crosses the 95% critical value at various points, suggesting the occurrence of bubbles in the relevant price series.

Table 3:Bubble Date Stamping for Commodity Prices (Jan 2000—May 2018)

Commodity	Number of bubbles	Start Date	End Date	Duration (months)
Wheat	2	May 2006	July 2006	3
		July 2007	Aug 2008	14
Rice	2	Nov 2004	Oct 2005	8
		Jan 2006	Oct 2008	34
Cotton	3	Oct 2003	Jan 2004	3
		Feb 2008	Sep 2008	8
		Dec 2009	May 2011	18
Sugar	3	Sep 2005	Jul 2006	11
		May 2009	Feb 2010	10
		Oct 2010	Mar 2011	6
Maize	4	Nov 2006	Mar 2007	5
		Dec 2007	Sep 2008	10
		Oct 2010	Nov 2011	14
		Jan 2012	Mar 2013	15

Barley	3	Oct 2006	Sep 2008	24
		Apr 2012	Mar 2013	12
		Aug 2014	Oct 2014	3
Soybean	5	Jan 2004	Apr 2004	4
		Jun 2007	Sep 2008	16
		May 2009	Nov 2009	7
		May 2012	Feb 2013	10
		Jun 2013	Feb 2014	9

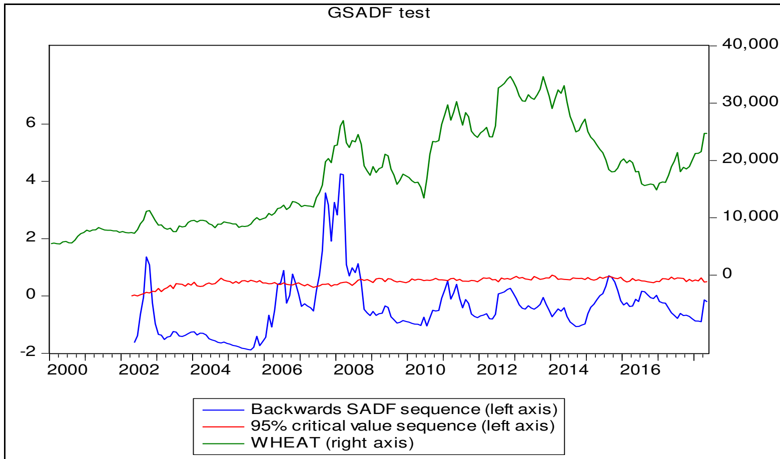
The plausible reasons for the existence of bubbles in wheat series in period Jul 2007 to Aug 2008 may be due to several reasons including global food crisis that occurred during the same period along with climatic factors, domestic shortage due to miscalculation of wheat and illegal exports to Afghanistan. In addition, government interventions, inefficient policies and currency depreciation also played a part in increased prices (Ahsan et al., 2011).

The longest bubble in rice is observed in the year 2006 to 2008 with a total duration of 34 months. This may be due to several factors such as global food crisis and drought, rising oil prices, demise in stock level, high demand for rising population, lower rice production, exchange rate movement as declining export price of rice, currency depreciation, export restrictions and high export tax on non-basmati rice imposed by India who is third large exporter of rice in March 2008 and later on complete ban was imposed which created a panic (Rosegrant, 2010; Hong et al., 2015).

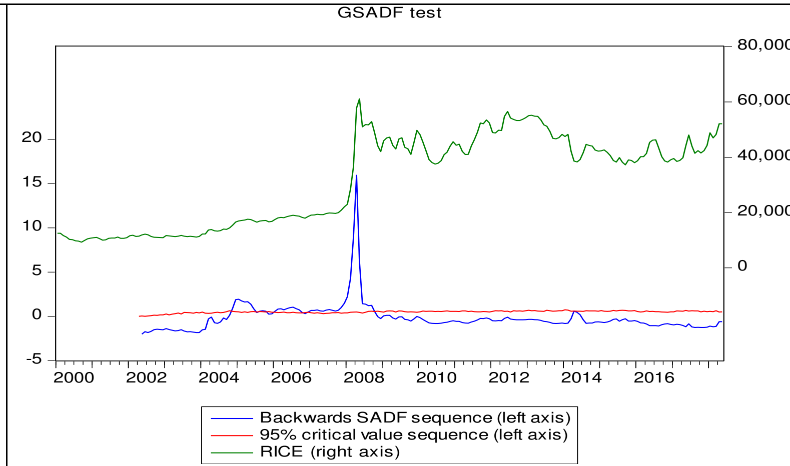
Since we know that cotton is the cash crop of Pakistan and it has larger share in exports. In the period of increased cotton prices, exports of textiles and clothing has been increased by 34.49%—from \$10.35 billion in 2009-10 to \$13.92 billion in 2010-11, giving incentive to cotton producers in these years (Zaidi, 2018). According to Abbas et al. (2015), various factors may have contributed to price hikes in cotton such as weak currency that leads to decline in relative price of export items. In addition, china imports cotton which has also caused the rise in price of raw materials. Further, flood in 2010 lowered cotton production as well as stocks, and this may have ultimately put higher pressure on prices. In addition, competition with synthetic fibers to subsidize the polyester plants to increase its production which act as cotton substitute have not only increased cotton price in Pakistan but across worldwide.

Various fundaments have escalated the sugar prices including non-existence of proper sugar policies, shortfall of stocks, high demand, improper information channel about the sugar situation in international markets and its impact on domestic economy (Joiya and Shahzad, 2015). The plausible reasons of existence of bubbles in barley, maize and soybean may be the global food depression, high biofuel industry demand, low stocks along with the stagnant production in wheat and tight global market.

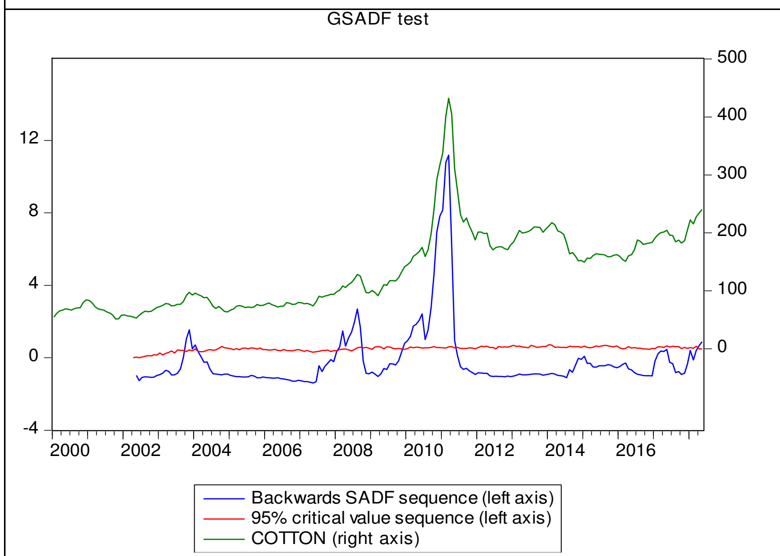
Figure 2: Bubble date-stamping of agriculture commodities



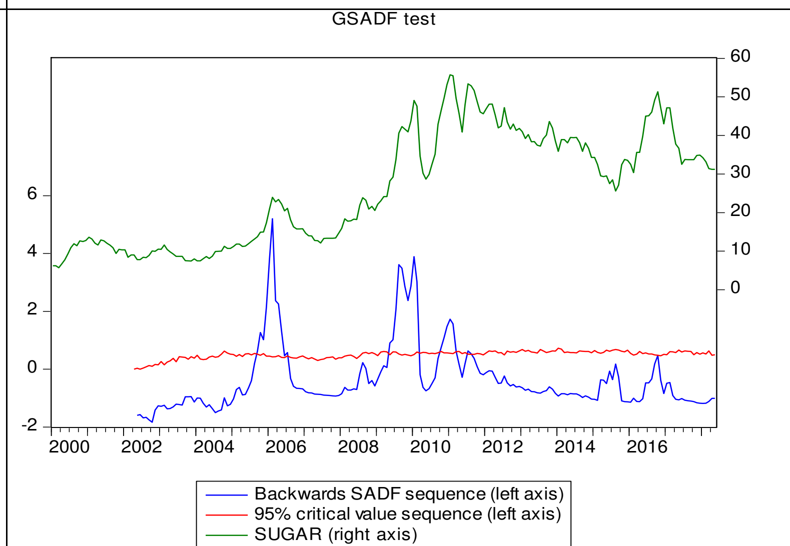
(a): Wheat price series



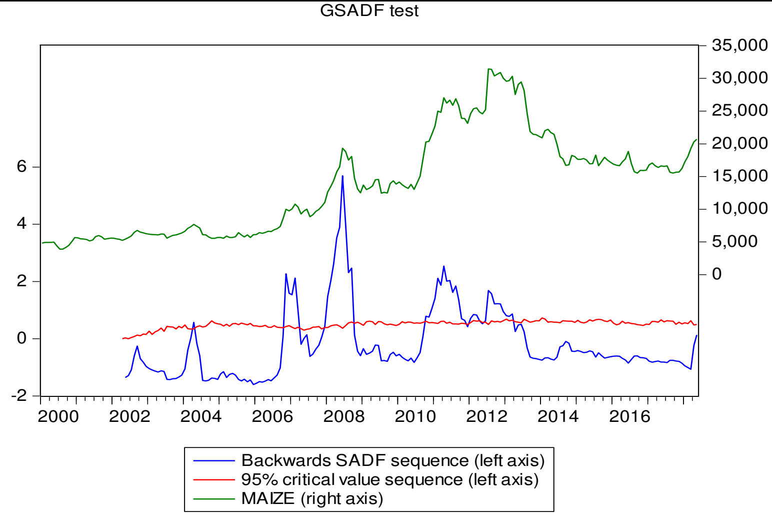
(b): Rice price series



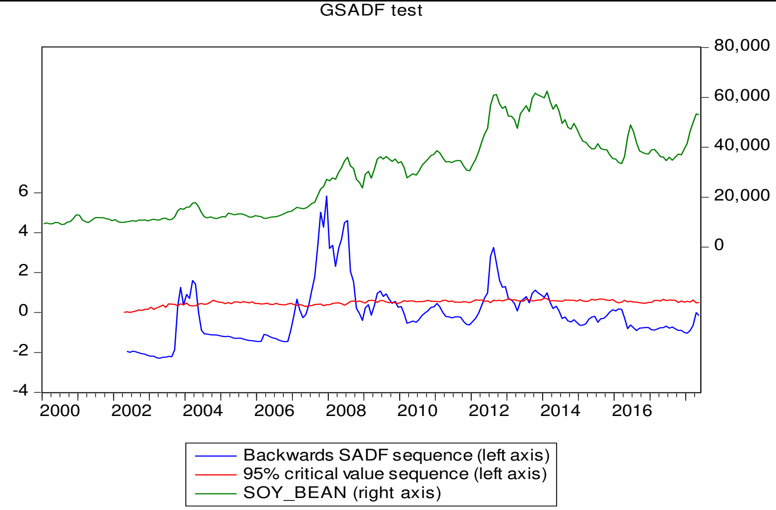
(c): Cotton price series



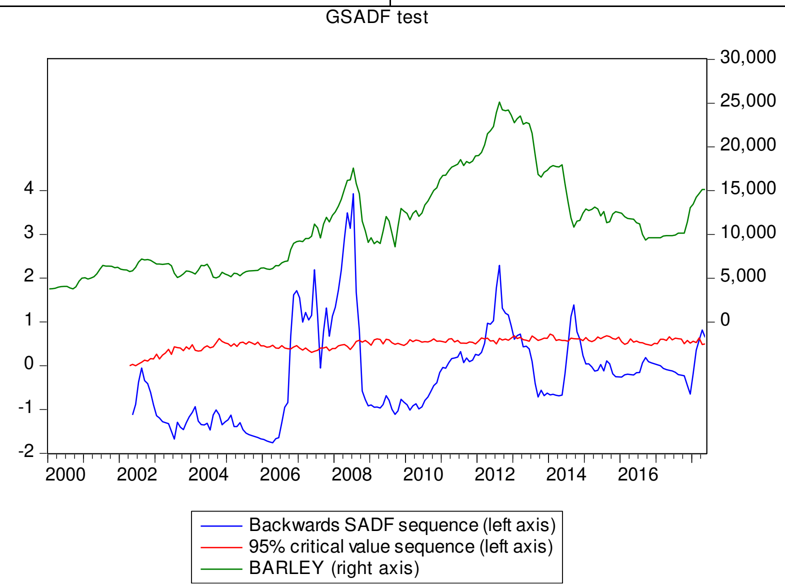
(d): Sugar price series



(e): Maize price series



(f): Soybean price series



(g): Barley price series

The empirical results presented in this paper are in line with the exisitng literature. In case of USA, see for example, Adämmer and Bohl (2015) for wheat, Gutierrez (2013) for wheat and rice, Etienne et al. (2013) for wheat, soybean and maize, Areal & Balcombe (2014) for major agriculture commodities prices while Diesteldorf et al. (2016) for wheat and cotton only, Alexakis et al. (2017) for corn and soybean. In case of China, see Li et al. (2015) and Wang et al. (2018) for corn, soybean, sugar and cotton. Our findings are in contrast with Liu et al. (2012) and Olsen & Stokes (2014) for wheat prices in USA, Spavound & Pavlidis (2016) for wheat in UK. Apparently, these findings are consistent with existing studies but are not directly comparable with them due to the difference in sample used, country chosen, and econometric technique adopted.

6. Conclusion

Pakistan being a developing economy has a large share of exports depending upon the agriculture sector in which price is the main determinant and plays a key role. This has caught attention of policy makers, researchers and public. Food insecurity is a global issue which got more attention after the 2008 global food crisis after which food prices are continuously rising and have deeply impacted the poor by creating high inflation, malnutrition and massive poverty as well as decline in exports affecting farmers adversely. The basic aim of sustainable development goals is to reduce poverty and malnutrition across the world and to reduce the food prices. So, it is very essential to bubbles because sudden rise or boom in prices of any commodity creates alarming condition for an economy usually caused by speculation and chaos of market participants in the commodity sector.

Numerous studies have been done in Pakistan regarding food insecurity and poverty, however, no single study is available on bubble detection in agriculture sector directly addressing the key issue. The present study is pioneer in nature and aims to figure out the price exuberance behavior in seven agricultural commodities price series (wheat, rice, barley, maize, soybean, cotton and sugar) in Pakistan. The empirical analysis is based on monthly time series data over the period of 19 years (Jan 2000—May 2018) with a total of 221 observations and the existence of single and/or multiple bubble(s) is examined using a state of art approach—the GASDF test to date stamp bubble.

The key empirical findings suggest that a total of 22 bubbles are observed in all the price series considered comprising of two each in wheat and rice price series with the longest one of 24 and 34 months respectively while the shortest ones are of 3 and 8 months respectively. Cotton, sugar and barley witness three bubbles each with longest one comprises of 18, 11 and 24 months respectively while the shortest one covers of 3, 6 and 3 months respectively. Similarly, in case of maize four bubbles have been noted with the longest one of 15 months duration while the shortest one is of 5 months and finally, five bubbles have been detected in the soybean price series with the longest bubble covers 16 months and the shortest comprised of 7 months.

As pointed out earlier that persistent price volatility and fluctuations can have deep social and economic effects in terms of inflation, poverty etc. It is very essential and rigorous task and a big challenge for policy makers to address these effects. One can use these empirical findings with other information such as influencing factors which may cause the bubbles that may help to predict the future price bubbles in the other commodity markets and can be prevented by taking appropriate steps. In these results, number of commodities such as maize, soybean, barley and rice have revealed bubble behaviors in recent years, which means close consideration should be given to formation and influencing factors of these bubbles and control the herding behavior.

It is also very necessary at first place to mitigate the pressure on prices of these markets by enhancing productivity growth and investment that has shown tendency towards bubble formation. Careful considerations should be given to exchange rate movements, inventory and stock maintenance, weather fluctuations, maintain demand and supply balance, speculative drivers and other macroeconomic factors which can lead to bubble formation.

According to Vousden (1990); Anderson & Nelgen (2010); Martin & Anderson (2011) worldwide export control policies in 2007—8 to protect the domestic consumers in short term, badly harmed the poor farmers. It has demolished the global economy and exasperated the commodity markets which caused boom in prices. It is very alarming and provide guidance to policy makers who attempted to protect the consumers by restricting exports at the expense of farmers which create volatility in prices. Besides this, government should consider the wider and negative effects of explosive bubble behavior and design the appropriate policies which actively respond to global events. Moreover, it should frame restrictions and barriers on excessive speculation under severe market circumstances to avert the immense price hikes and explosive behavior. The present study can be extended in many ways by going one step further and finding the causes of bubble formation empirically via a regression framework.

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Appendix: ***Table 4: Summary of Existing Studies***

S. No.	Author(s)	Country	Time-period	Data series	Methodology	Results
1	Robles et al. (2009)	US	2002M2—2008M2	wheat, rice, maize and soybean	Granger causality tests	Speculative movements have affected these price series
2	Went et al. (2009)	US	1960M3—2005M5	28 agricultural commodities	Duration dependence test	Speculative bubbles
3	Gutierrez (2010)	US	1985M3—2010M4	Wheat and rough rice commodity prices	Bootstrap	Price escalation is observed
4	Liu et al. (2012)	US	1989M1—2011M7	Wheat prices	Regime switching regression model	No bubbles are detected
5	Ad¨ammer et al. (2012)	US	1993M1—2012M12	Wheat and corn	MTAR & convenience yield models	Overvaluation in prices
6	Paulson et al. (2013)	US	1989—2011	wheat, corn, soybeans, rice, sugar and cotton	Regime switching regression model	Bubbles have occurred only in soybean prices
7	Gutierrez (2013)	US	1999—2008	wheat, corn, soybean and rice	Sup-ADF & Bootstrap	Bubbles have occurred in all series except for soybean
8	Etienne et al. (2013)	US	2004—2011	12 agriculture markets	ADF test	Multiple periods of price explosiveness have found. Both positive and negative bubbles are detected
9	Anestina et al. (2013)	South-West, Nigeria	2001—11	8 Maize markets	OLS and residual augmented dickey fuller test,	Bubbles have occurred in 5 markets
10	Liu et al. (2013)	China	1989M1—2011M12	wheat, rough rice, corn, sugar, soybeans and cotton	Regime switching regression model	Bubbles have occurred only in soybean.

11	Areal et al. (2014)	US	1990M1—2012M8	Food and agricultural commodities	GSADF	Price bubbles have found.
12	Etienne et al. (2014)	US	1970—2011	12 agricultural markets	Sup-ADF	Short-lived bubbles have occurred.
13	Li et al. (2014)	China	2006M1—2014M12	Wheat, corn, soybean, cotton sugar and food oil	recursive right tailed unit root & Zero-inflated Poisson model	Speculative bubbles have occurred.
14	Olsen & Stokes (2014)	US	1950—2012	Farmland prices	Non-linear least square and OLS	No bubbles have detected
15	Etienne et al. (2015)	US	2004M1—2014M8	hard red spring wheat market	Recursive bubble testing procedure	Short lived bubbles have found
16	Lia et al. (2015)	China	2006—2014	Agriculture commodity prices and macroeconomic variables	GSADF	No bubbles found in wheat while in all other cases bubbles exist
17	Adammer & Bohl (2015)	US	1993M1—2013M12	Corn, wheat and soya bean	(MTAR)	Bubbles exist in wheat while results are inconclusive for corn & soybean
18	Ma et al. (2015)	China	2002M6—2013M8	Soybean, maize, wheat, colza oil, and japonica rice	Granger causality test	Oil prices and exchange rate have no effects on bubble formation
19	Diesteldorf et al. (2016)	US	1980M1—2015M6	Ten agriculture commodity future markets	GSADF	Explosive behavior has found in wheat, feeder cattle, cocoa, coffee and cotton
20	Caramugan & Bayacag (2016)	ASEAN countries	1980—2015	ASEAN exports (rubber, palm oil and rice)	recursive SADF and GSADF	Bubbles has found in three of the commodities
21	Spavound & Pavlidis (2016)	UK	2003—2015	UK wheat market	Wild Bootstrap GSADF, ADF, GSADF	No bubbles exist.
22	Areal et al. (2016)	US	1980—2012	Agriculture commodity	GSADF	Multiple bubbles exist

23	Alexakis et al. (2017)	US	2001M1—2016M4	hogs, corn and soya bean	BSADF	Bubbles are found
24	Wang et al. (2018)	China	1990M1—2017M12	Food prices	GSADF & SADF	4 bubbles are detected

Note: BSADF= Backward Supremum Augmented Dickey Fuller, GSADF=Generalized Supremum Augmented Dickey Fuller, MTAR= Momentum threshold autoregressive approach, OLS= Ordinary least square