Testing for Multiple Bubbles in Inflation for Pakistan

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Abstract

Detection of bubbles in financial markets is an issue of great importance as these split an enduring impact to every sector of the economy leading to substantial losses. In Pakistan, price level has seen abrupt changes which hurts the economic efficiency whereas inflation rates are usually high. So, it is important to detect bubbles present in inflation to have a check whether the hike in inflation is demand driven or there is a prevailing price exuberant behavior that results in sudden boom in inflation. There are very limited studies on detecting bubbles in inflation series for Pakistan. So, the present study takes a lead and address this very important issue by making use of recently developed state of art GSADF approach proposed by Phillips et al. (2015). The empirical analysis is based on five different series which cover inflation rates such as consumer price index (CPI) for the general, the food and the non-food items, the sensitive price index (SPI) and the wholesale price index (WPI). This approach is best suited for testing multiple bubbles as opposed to earlier methods that are designed to test for the presence of only a single bubble in any time series. The empirical findings based on monthly time series data from Jan 2006 to Jan 2019 confirm the existence of multiple bubbles in WPI and CPI non-food. However, for rest of three series, only single bubble has been witnessed. The analysis from the date stamping of bubbles reveal that all bubbles arise during the global financial crisis of 2008 which triggered oil prices resulting in domestic currency depreciation. Some important policy implications are discussed as well.

Key Words: Explosivity; Consumer price index; Wholesale price index, Sensitive price index; GSADF; Simulation

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1. Introduction

A bubble is defined as the rapid shoot up of prices followed by a sudden sharp decline lowering down the prices drastically. This is the condition when prices of an asset deviate too much from their fundamental values and no one is willing to buy at the prevailing price, leading to an abrupt decline in the value of the asset which finally deflates the bubble (Diakoumi, 2015). Bubbles are formed in the markets due to investor's exuberant behavior. Investors get signal to invest when asset price begins to escalate and for the sake of abnormal profits, investor raises its expectations for further hike in the value of asset, and because of this, prices drives to the point where these go beyond their productive capacity that no one is willing to buy any more. Later, prices drastically decline, and everyone starts selling the owned assets and this creates a panic in the markets (Kindleberger, 1992).

Vast amount of literature has been devoted to empirically test the presence of economic bubbles in different contexts, see for example, Brooks et al. (2001), Belke and Wiedmann (2005) and Goodman and Thibodeau (2008) for housing markets; Rosser and Ahmed (1995), Bohl (2002), Brooks and Katsaris (2003) and Phillips et al. (2011, 2013) for stock markets; Wu (1995) for exchange rate markets; Flood and Garber (1980) and Engsted et al. (2015) for inflation and Caspi et al. (2015) for the commodity price bubbles. Recent studies on crypto currency are done by Cheung et al. (2015), Cheah and Fry (2015), Fry and Cheah (2016).

As inflation is a global macro-economic issue and post-2008, world has seen sudden escalation in food and oil prices due to which inflation reached to extremely high level in Pakistan in 2008, reaching to almost 20% in country where income level for 60% of population is very low and more than half of the population earns less than $2 a day. So, a rise in food and oil prices immensely burdens the poor and middle-income earners as majority of their income portion is spent on food and other essential items. Hence, it is very critical to explore this issue in Pakistan and to assess whether the hike in inflation is due to demand driven fundamental reasons or there is a price exuberant factor that causes boom and bust in inflation rates.

Tracing back the history of financial bubble, the tulip mania during the Dutch golden rule in 1637 is regarded as the first economic bubble when prices of tulip bulb increased

creating further demand for tulips. Due to price hike, tulip was considered a luxury but suddenly when big purchasers failed to buy, the price suddenly fell resulting in drastic collapse. This created panic throughout the Europe leading to huge disruption in market.

The dot-com bubble is also regarded as the internet bubble that took place in the 1990s when the internet adoption and extreme growth in internet technology happened triggering the investment in equity of internet, technology companies and e-commerce sites. As investors poured their money in internet startups which rose the demand for those equities due to which stock prices surged and stock market saw an incredible new height. However, after March 2000, the value of these stocks drastically declined due to which many companies were forced to shut down and others lost their market values from high notch companies to worth-less.

A real estate bubble is witnessed in the United States housing market when housing prices up surged in 2006. But a sudden decline to historically low value in later part of 2006-07 resulted in financial crisis and caused markets to crash which created recession in US. The US government had to rescue the economy by allocating over $900 billion devoted for housing bubble. Half of the US economy was affected which further caused subprime mortgage crisis. This issue left a deep and a long-lasting impact on US economy.

In 1997 world witnessed some financial bubbles in Asian financial crisis which impacted Singapore, Malaysia, Indonesia, Taiwan, Philippines and South Korea, where currency and stock market crisis affected the whole economy. All the major and high-income countries faced real estate asset and stock market bubbles like Japan in 1986-1991, China in 2003-2007, India in 2003-2007 and Australia and other European countries. The detection and research on bubbles is significant because sudden crash and eruption of the bubble causes a disruption in economic activity due to which economies have faced recession during that time, because of not having a quick and timely response to mitigate this. However, government had to intervene as declining incomes, unemployment could happen due to these crashes, whereas financial stability can also hurt. Many economists have used different adjectives to the bubbles like speculative (Hamilton, 1986), rational (Shiller, 1981), (LeRoy and Porter, 1981). The other names used for bubbles which have been used in literature are

explosive etc. This issue gained momentum after the US housing bubble which leads to a vast research on US housing crisis and stock market bubbles.

There are very limited studies which focuses on detecting economic bubbles in different financial markets in Pakistan. No single study has been done for testing bubbles in inflation series for Pakistan. The present study takes a lead and addresses this very important issue. In particular, the study considers five different inflation rates including the general consumer price index (CPI), the CPI for the food and the non-food items, the sensitive price index (SPI) and the wholesale price index (WPI). The empirical results are based on latest available monthly time series data from Jan 2006 to Jan 2019. The detection of bubbles is made possible by the recently developed generalize supremum ADF (GSADF) approach by Phillips et al. (2015) which has several advantages over the conventional rival approaches in the sense that it can detect multiple bubbles which was not possible earlier. The empirical results suggest that bubbles (single as well as multiple) exist in all the five series considered. These results have important policy implications which are discussed in the later sections.

Rest of the paper is organized as:

Section 2 provides a detailed literature review of the existing studies with their critical analysis. Section 3 discusses the theoretical framework and econometric methodology. Section 4 contains results and discussion while last section portrays the conclusion of the study with some suitable policy recommendations.

2. Literature Review

There exists vast literature on the bubble detection not only in the inflation series but also on different markets like stock, foreign exchange and housing market. The literature is critically reviewed, and research gap is discussed. Regarding existence of bubbles in inflation series, studies have been done for several countries including Poland, Germany, OECD, Brazil, Argentina, among others, by employing various estimation approaches such as vector autoregressive (VAR) models, ADF-type tests and the Generalized supremum ADF test. The detailed review is provided below:

Flood and Garber (1980) tests for price level bubbles during German hyperinflation period. The study examines how market prices deviate from fundamental values to high levels in the presence of bubbles using Monetary Model of hyperinflation (1956). Empirical analysis is done using time series data $1920M_7$ to $1923M_6$. The techniques used to test bubbles are the ones introduced by Salemi and Sargent (1979) and Hansen and Sargent (1979). The findings from these tests suggest that some solid empirical evidence is needed for proving the existence of bubbles. As bubbles are not found for the sample data and further investigation is required.

Welch (1991) tests for existence of bubbles in inflation for Argentina and Brazil by using time series data of inflation from 1985-1990. Phillips Perron (1988) and ADF test (1979) test is employed for testing inflationary bubbles. The findings conclude that inflation in these two countries is due to the fundamental reasons and the study opposes the possibility of bubbles in inflation. Rosser and Ahmed (1995) inspects for bubbles in Pakistan stock exchange market for the time-period starting from June 1987 to May 1993. Different techniques are used to detect the presence of bubbles in stock market such as vector auto regressive (VAR) and Hamilton switching model (1989). The findings conclude that the speculative trends and bubbles are not present in stock market on the data for these 6 years. So, stock prices are volatile due to uncertainty in Pakistan's economy which is reflected in stock market as well.

Liu and Chang (2008) inspects for existence of bubbles in South Korea stock market by making use of monthly time series data from May 1996 to November 2007 by employing different co integration tests by taking stock prices index and dividends data. The study uses unit root test, co integration based on Johansen and Juselius (1990) approach, co integration test based on nonlinear (KSS) (Kapetanois et al., 2006) unit root and nonparametric (BN) (Bierens,1997, 2004). The findings show that Johansen and Juselius (1990) test supports the presence of bubbles while the other two tests KSS and BN approaches reject the occurrence of bubbles in South Korea's stock market.

Phillips et al. (2011) investigates NASDAQ stock market behavior by using a new methodology called recursive and explosive regression test. The analysis is based on monthly

data from 1973M_2 to 2005M_6 on the Nasdaq composite price index and Nasdaq composite dividend yields by applying ADF (1979) and sup ADF approach. The study also considers consumer price index (CPI) data from 1973M_2 till 2005M_6. The findings reject the null hypothesis of no explosiveness, which confirms bubbles presence in NASDAQ stock prices.

Chang et al. (2014) tests for multiple bubbles in BRICS stock market using monthly stock values and dividend data for these five countries spanning over 1990 to 2013 by using SADF and GSADF given by Phillips et al. (2013). The results show that multiple bubbles occurred in these stock markets and are linked to events in these stock markets and these have a negative financial impact on these markets.

Shih et al. (2014) investigates for bubbles in Chinese housing market and the inter-provincial spill over impacts by employing Lagrange multiplier (LM) unit root unit test (2003), cointegration test (Qu 2007) and Granger causality test (1969) to test for spillover impacts. By taking housing data of 28 provinces of china over the period 2000Q1 to 2012Q4, the analysis confirms the presence of bubbles in most of the provinces. In addition, the housing prices which have spillover impact are integrated together and extended impact of bubbles are found in Shanghai and Beijing.

Cheung et al. (2015) examines the presence of bubbles in bitcoin market which has captured much media attention due to its price volatility, however, academic and empirical investigation is still missing on this subject in existing literature. Daily Time series data from 17 July 2010 to 18 February 2014 is used to carry out empirical analysis based on GSADF test proposed by Phillips et al. (2013a). The findings show that most of the bubbles are short lived with three major bubbles are found during the period 2011 to 2013 that last about 60 to 100 days.

Caspi et al. (2015) examines for explosiveness in oil prices. Speculative bubbles are tested using GSADF technique by (Phillips et al., 2013). The empirical analysis is based on monthly data on WTI crude oil prices ranging between January 1876 to January 2014. The GSADF technique confirms the presence of bubbles in oil prices. Specifically, time period between 1941 and 1973, shows high level of speculative impacts on prices which shoots up prices during this period. Overall findings confirm the presence of bubbles.

Zeren and Erguzel (2015) inspects for bubbles in Turkey housing market by using GSADF unit root approach introduced by Phillips et al. (2011). The empirical analysis is based on using monthly from Jan 2010 to June 2014 data on three biggest cities housing market, İstanbul, İzmir and Ankara. The findings oppose the possibility of bubbles during the selected time-period and efficient market hypothesis holds true on Turkey housing market and prices aroused due to market factors.

Phillips et al. (2015) tests multiple bubbles in S&P 500 and the price-dividend ratio using GSADF test (Phillips et al.2011). The data time span stretches from $1871M_1$ to $2010M_{12}$. The study tests single, multiple and no bubble using different techniques and the findings show that multiple bubble exists. The empirical findings favor GSADF technique as it suits best and date stamps bubbles in financial market. Empirical findings approve the existence of bubbles in S&P 500 price dividend ratio.

Ahmed et al. (2016) tests for nonlinear speculative bubbles in Karachi stock exchange using KSE100 index daily data since 1992, stock prices, and exchange rate of PKR per USD as well as short-term interest rate. For testing bubbles different techniques are used such as Hamilton switching test (1989)., Hurst coefficient test (1951).and a further test for nonlinearity which is ARCH "autoregressive conditional heteroskedasticity"(1982). The findings from these tests opposes the null hypothesis of no bubbles which confirms the presence of bubbles in stock exchange market and it shows that stock prices are volatile.

Shi et al. (2016) examines for housing prices bubbles in some Australian cities by using GSADF approach of Phillips et al. (2015). Monthly housing prices data from December 1995 to August 2015 and rental prices are examined. The results show that bubbles are present in housing market. Brisbane has a lesser effect of bubble as compared to Perth which is longer due to commodity prices hike. The results also provide an evidence on current bubble in Sydney housing market since December 2013 and in Melbourne since July 2015.

Liu et al. (2017) examines bubbles in Chinese (CPI). The study uses GSADF by (Phillips et al 2011). The study takes in account monthly data on Chinese CPI from $2006M_{12}$ to $2014M_1$ to test the occurrence of bubbles in inflation series. The findings confirm four bubbles during 2007 to 2014 while the longest one is during the period November 2010 to

May 2012 which is primarily due to labor shortage which raises wages and results in elevated cost of production. The rural CPI bubble is found to be bigger than urban CPI.

Pavlidis et al. (2017) tests for bubbles in exchange rate by considering forward and spot rates using—the GSADF test (Phillips et al. 2011). The analysis is done on German mark and US dollar exchange rate during interwar Germany hyperinflation period. The data set on spot and forward exchange rate is taken from 1921 to 1923. The findings oppose the acceptance of null hypothesis which implies no bubbles. The evidence from hyperinflation period states that bubbles are present during 1921-1923 for two short periods which cause the exchange rate fluctuation.

Balcilar et al. (2018) analyzes the presence of bubbles in US housing prices during the time period 1830 to 2013 by applying Generalized ADF (GSADF) approach introduced by Phillips et al. (2011). Annual Data on housing prices and CPI data is taken over the period 1830 to 2013. The findings from GSADF test indicates three short time spans of bubbles in housing prices during late 1800s and mid 1950s and mid 2000s which confirms bubbles presence, and this derives further demand leading to even high prices.

From the thorough literature review, it can be noted that very limited studies are available on Pakistan for the detection and existence of bubbles. In fact, no prior study is available that focuses on the case of bubble detection in inflation series though few studies are available on bubble detection for the stock markets. Moreover, no prior work exists that discusses the issue of bubbles detection in the popular inflation measures, the consumer price index (general, food, non-food), the wholesale price index and the sensitive price index across the globe. Thus, the present study makes a significant contribution to the existing literature by considering five key indices of inflation (CPI general, food and non-food, WPI and SPI general) for Pakistan.

3. Theoretical Framework and Econometric Methodology

3.1. Theoretical Framework

The theoretical framework is built on the theory of the relation between prices and dividends on the stocks (for details, see, Koustas and Serletis, 2005; Cuñado et al., 2005 and Campbell et al., 1997). To have a better understanding of the rationale behind the time series tests of assets pricing bubbles, consider the simple asset pricing equation.

$$P_t = \sum_{k=0}^{\infty} \left(\frac{1}{1+risk_f}\right)^k E_t(Div_{t+k} + UF_{t+k}) + B_t \qquad [1]$$

Where, P_t is the price of assets after-dividend, $risk_f$ is the risk-free interest rate, Div_t is the dividend received from the asset, UF_t is the unobserved fundamentals while B_t represents the bubble component. Note that the following expression holds for B_t, known as submartingale property:

$$E_t(B_{t+1}) = \left(1 + risk_f\right)B_t \qquad [2]$$

The market fundamental is commonly calculated as the difference between the price and the bubble component, i.e., $P_t^f = P_t - B_t$

Note that, for the case when $B_t = 0$, i.e., when there are no bubbles then dividend and unobserved fundamentals are the only factors responsible for controlling the non-stationary behavior of asset price P_t. If $Div_t \sim I(1)$ & $UF_t \sim I(0)$ *or* $I(1)$, then P_t will be either I(0) or at most I(1). Alternatively, if martingale condition in [2] holds then in the presence of bubbles, P_t will be explosive. The explosivity of P_t can be linked to existence of bubbles in P_t for the cases when $Div_t \sim I(1)$ & $UF_t \sim I(0)$ *or* $I(1)$.

3.2. Econometric Methodology

The econometric methodology used in this study is based on the efforts initiated by Phillips et al. (2011) proposing the supreme version of standard ADF test—the SADF technique for detecting single bubble in a time series followed by the generalized SADF (GSADF) approach by Phillips et al. (2015) for the detecting of multiple bubbles which is an

extension of SADF. The GSADF method can consistently detect and date-stamp multiple bubble episodes.

To provide deep insight of these approaches, consider the following regression model:

$$Z_t = \eta_1 + \eta_2 Zt - 1 + \sum_{l=1}^{q} \gamma_l \Delta z_{t-l} + \epsilon_t \qquad [7]$$

Where, Z_t denotes the price index series (CPI general, food and non-food items, SPI and the WPI), η_1 is the intercept and η_2 is the coefficient of first lag of Z_t (i.e. Z_{t-1}) and γ_l is the coefficient of Δz_{t-l} , ϵ_t is a zero mean and constant variance error term and q is the optimal lag-length chosen via Akaike or Schwarz information criterion.

To test for the existence of bubbles (explosive behavior), the following null and alternative hypotheses are formulated: $H0: \eta_2 = 1; H1: \eta_2 > 1$

To understand the discussion that follows, let's introduce some notations. First the sample is normalized to cover the range from observation 1 to T into [0,1] interval. Let $\eta_{s1\,s2}$ and $ADF_{S1\,S2}$ respectively denote the estimated coefficient of z_{t-1} in [7] and the equivalent ADF statistic over the normalized sample [s_1,s_2]. Further, let w_s=s_2- s_1 be the fractional window size with w_0 as the initial window size.

Before explaining SADF and GSADF test, it is good to understand first right tailed version of standard ADF unit root test (RTADF). For RTADF, the starting and ending observation of chosen sample are $s_1 = 0$, $s_2 = 1$, and the window size w_s=1. It is important to note that the critical values of RTADF will be different from the standard ADF test because RTADF is a right tail test in contrast with the standard ADF unit root test which is a left tail test. The null hypothesis of unit root gets rejected if calculated value of $ADF_{s1,s2}$ is found to be bigger than the corresponding critical value (90%, 95% or 99%) leading to the the evidence of a bubble.

The SADF test is based on right tail unit root test. The main idea behind the SADF approach is to estimate RTADF statistic recursively by considering a fixed starting point ($s_1 = 0$) and with an increasing window with window size s_w= s_2 calculated via 0.01+1.8/$\sqrt{T}$. Then the regression is estimated by increasing the window size, $s_2 \in [s_0, 1]$ and each estimation of regression model gives an ADF statistic (ADF_{s2}). The final estimation is done on whole

sample, i.e. by considering $s_2 = 1$. The SADF statistic is the supremum value of ADF_{s2} for $s_2 \epsilon [s_0, 1]$, given by:

$$\text{SADF}(s_0) = \underbrace{sup}_{s_2 \epsilon [s_0,1]} \{ADF_{s2}\}$$

A problem with the SADF is that it can't detect multiple bubbles, so to overcome this, the GSADF approach is proposed by Phillips et al. (2015) which can detect multiple bubbles (See, Fatima and Ahmed, 2019, for details). In the GSADF approach, the starting point s_1 is also allowed to change within the range [0, $s_2 - s_0$]. The GSADF test is calculated on the estimates of the backward sup ADF test repeatedly for each $s_2 \in [s_0, 1]$ and the decision is done on the sup value of the backward sup ADF statistic, therefore GSADF is denoted as;

$$\text{GSADF}(s_0) = \underbrace{Sup}_{\substack{s_2 \epsilon [s_0,1] \\ s_1 \epsilon [0, s_2 - s_0]}} \left\{ ADF_{s_1}^{s_2} \right\}$$

The date stamping of bubbles is done by comparing the estimated Backward-SADF (BSADF) values against the right tail critical values of the standard ADF to detect a bubble at a time T_{s_2}. The beginning point of bubble is when the $BSADF_{s_2}$ crosses the critical value so when $BSADF_{s_2} > CV$ bubble emerges denoted by $\hat{s}_{start}$ while the ending point of bubble is noted when the $BSADF_{S2}$ goes below the CV (i.e., when $BSADF_{s_2} < CV$) bubble pops out denoted by $\hat{s}_{end}$. So, the estimates of bubble period can be denoted as follows,

$$\hat{s}_{start} = \underbrace{inf}_{s_2 \in [s_0,1]} \left\{ s_2 : BSADF_{s_2}(s_0) > crit_{S_2}^{\beta_{T_{s_2}}} \right\}$$

$$\hat{s}_{end} = \underbrace{inf}_{s_2 \in [\hat{s}_{start},1]} \left\{ s_2 : BSADF_{s_2}(s_0) < crit_{S_2}^{\beta_{T_{s_2}}} \right\}$$

Where, $crit_{S_2}^{\beta_{T_{s_2}}}$ is $100(1 - \beta_T)\%$ critical value of BSADF statistic on $\left[T_{s_2}\right]$ observations. BSADF(s_0) for $s_2 \epsilon [s_0, 1]$ is the backward SADF statistic and it related to GSADF as:

$$GSADF(s_0) = \underbrace{sup}_{s_2 \in [s_0,1]} \left\{ BSADF_{s_1}^{s_2} \right\}$$

4. Data and Empirical Results

4.1. Data and its sources

The study considers monthly series of consumer price index (CPI), sensitive price index (SPI) and the whole sale price index (WPI). For CPI, three series are considered, the general CPI (CPIG), the CPI for the food items (CPIF) and the CPI for the non-food items (CPINF). So, in total, five series are considered for analyzing their explosive behavior. The empirical analysis is carried out using latest time series data available for all five series starting from Jan 2006 till Jan 2019. The choice of time span is based upon data availability, in most cases, the data prior to 2006 wasn't available. All the data is taken from the State bank of Pakistan (SBP) website.

The detailed description of the data series is as follows: CPI examines the change in price level of a basket of goods and services. Specifically, the changes in the cost of buying a basket of goods and services constitutes the CPI. The CPIG measures the overall change in price level which includes both the food and non-food items (487 items in total, categorized into 12 groups as per Pakistan Bureau of Statistics (PBS)). The CPIF examines the changes in price level of food items only which are necessity items for a consumer, and it excludes non-food items and services which are included in CPINF which considers the non-food items like education, health, housing, clothing, transportation, fuel etc. The SPI measures the change in price level of basic commodities on weekly basis to examine the prices position in the country. It includes 53 items. The WPI measures the changes in prices of whole sale markets. It considers the goods that are primarily used by producers and manufactures which 463 items divided in five groups[3].

Figure 1—2 respectively portrays the time series plot of (CPIG, CPIF and CPINF) and the SPI and WPI for the selected period.

[3] The list of items included in CPIF, CPINF, SPI and WPI is available at Pakistan Bureau of Statistics (PBS) website: http://www.pbs.gov.pk/

Figure 1: Consumer Price Index (CPI) (Jan 2006—Jan 2019)

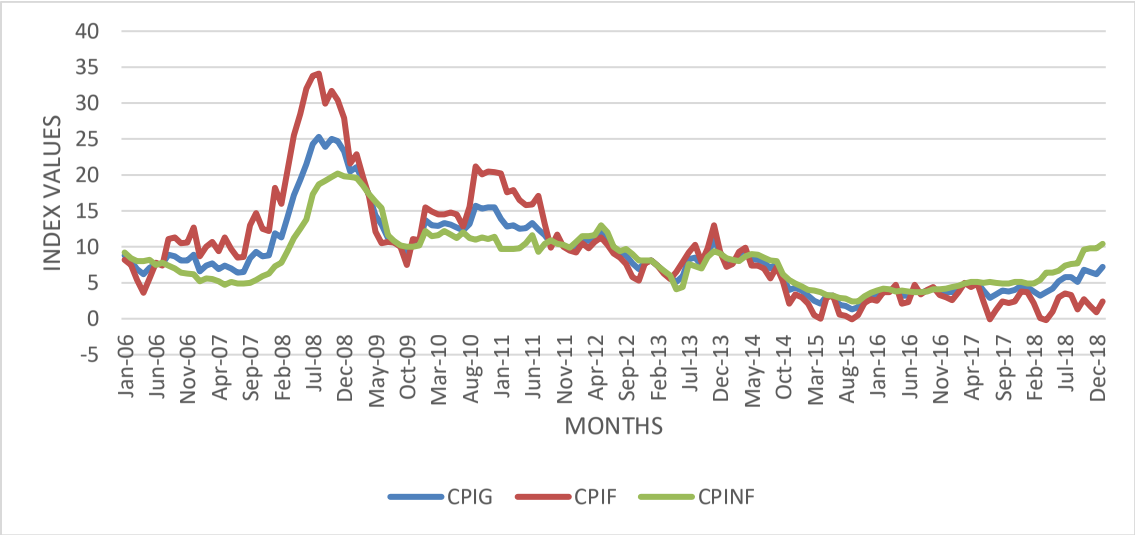
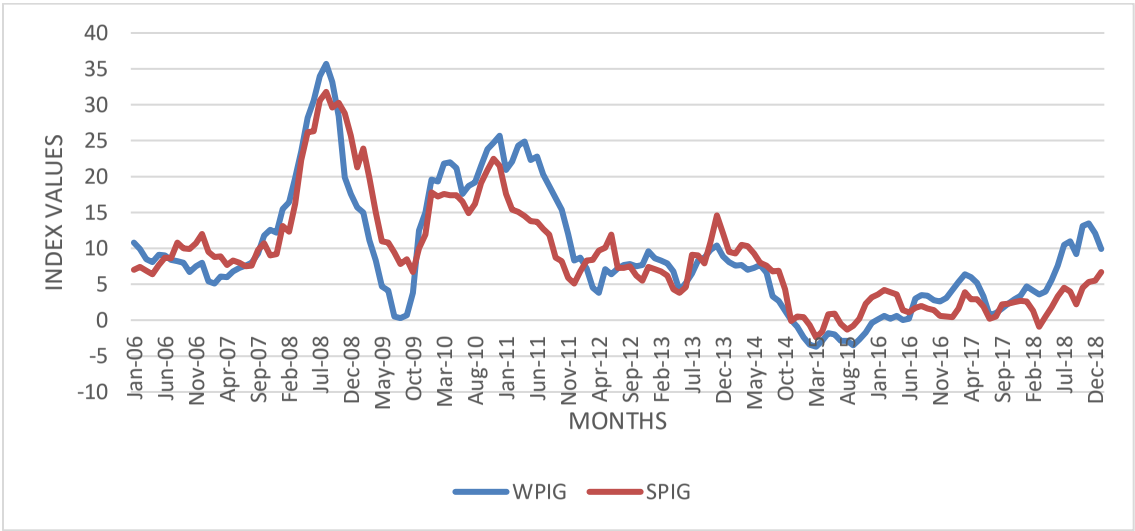


Figure 2: Sensitive Price Index and Whole Sale Price Index (Jan 2006—Jan 2019)



4.2. Empirical Results

Table 1 provides the descriptive statistics of all five series included in the study (CPIG, CPIF, CPINF, WPI and SPI).

Table 1: Summary Statistics for CPI, WPI and SPI

Variable	Mean	SD	Median	IQR	Skewness	Kurtosis	Min	Max
CPIG	8.87	5.24	7.90	6.70	1.20	4.37	1.30	25.30
CPIF	9.59	7.54	8.50	9.10	1.23	4.41	-0.20	34.10
CPINF	8.33	4.03	8.00	5.40	1.05	4.01	2.40	20.20
WPI	9.28	8.37	7.70	9.00	0.92	3.49	-3.70	35.70
SPI	8.85	7.33	7.70	8.60	1.07	3.96	-2.40	31.80

The results for the SADF and GSADF statistics are presented in Table 2 with corresponding critical as well as p-values. It can be noted that the null hypothesis of no bubble gets rejected in all five series except for the CPIF for the GSADF test. However, it is rejected at 10% significance level for SADF for the same series. For the rest of the series, the results suggest the existence of bubbles. The same results is seen if critical value are used.

Table 2: Results of GSADF statistic for Inflation Series

Series	SADF	GSASF
CPIG	3.30** (0.01)	3.25*** (0.00)
CPIF	2.36** (0.08)	1.37 (0.27)
CPINF	3.16** (0.01)	5.10*** (0.00)
SPI	3.13** (0.01)	2.50** (0.02)
WPI	4.83*** (0.00)	4.79*** (0.00)
Critical Value	**SADF**	**GSASF**
1%	3.29	2.74
5%	2.68	2.06
10%	2.29	1.76

a) **Notes:** The p-values of each test statistic are presented in parentheses for all series.
b) ***, ** and * respectively denote significance at 1%, 5% and 10% significance levels.

Table 3 shows date stamping period series for the selected period. The start and end dates of bubble are provided along with the duration of bubble in months.

Table 3 Bubble Date Stamping (JAN 2006—JAN 2019)

S. No.	Series	Start Date	End Date	Duration (Months)
1	CPIG	April 2008	December 2008	9
2	CPIF	April 2008	August 2008	5
3	CPINF	April 2008	January 2009	10
		April 2018	January 2019	10
4	SPI	April 2008	November 2008	8
5	WPI	January 2008	October 2008	10
		December 2014	April 2015	5

From Table 3, it can be noted that a bubble in CPIG series has been witnessed which emerges in April 2008 and bursts in December 2008 with a total duration of nine months. Other than this, no additional bubbles have been witnessed during the chosen time period for the study (January 2006—January 2019). In the CPIF series, only single bubble is emerged with a time span of 5 months from April 2008 to August 2008. The SPI series also witnesses a single bubble of 8 months duration while the CPINF and the WPI witness multiple bubbles.

The plausible reasons for the presence of bubble in all the three CPI series are the rising staple food prices like wheat, rice, milk, vegetables and cooking oil which are essential food items and are allocated high weights in CPI (PES, 2007-08). There was a general rising trend in inflation throughout 2008 which was due to different factors. As Pakistan is an import-based economy and heavily depends on oil imports which impact the whole price level in economy. As in 2008, the Brent oil prices rose sharply, in Jan 2008, it was $92.21 per barrel and it went up to $139.83 per barrel in June 2008, an overall rise of 51.6% due to which domestic oil prices rose sharply (PES, 2008). The upsurge in oil prices splits its impacts to every sector of the economy resulting a rise in prices of transportation and cost of manufacturing of every good produced in the economy.

Secondly, the reason was the depreciating value of Pakistani rupee (PKR) in terms of US dollar which made imports quite expensive and at the same time the Pakistani rupee value

depreciated, and oil prices were on a rising trend which doubled the impact of rising domestic petroleum products. In March 2008, $1 was of 62 PKR and it rose up to 80 PKR in October 2008 (PES, 2007-08). A depreciation of 29% and 51.6% rise in oil price jolted the economy. Price of Motor Gasoline went from 58.7 PKR per liter in March to 86.66 PKR per liter in August in a span of just 5 months the price rose 47.6% and this change was reflected in the CPI value as went upwards, and inflation goes beyond double digit.

The monthly CPIF value was 20.6 in March 2008 and rose up to 34.1 in August 2008 (SBP). This upward trend was caused by surge in the prices of some essential food commodities which are as, wheat (76%) pulse masoor (130%), rice (121%) (Monthly Inflation monitor, August 2008, State bank of Pakistan). Sindh and Baluchistan were affected due to cyclones and monsoon rainfall which resulted in floods. Khyber-Pakhtunkhwa was also badly affected due to melting of glaciers and excessive rainfall. Due to these floods in three provinces crops of vegetable, fruit and other food items were destroyed which resulted in supply bottlenecks and caused a rise in prices. Globally, there was a general rising trend in global food prices as during end of 2007 to mid of 2008 food prices were on a hike.

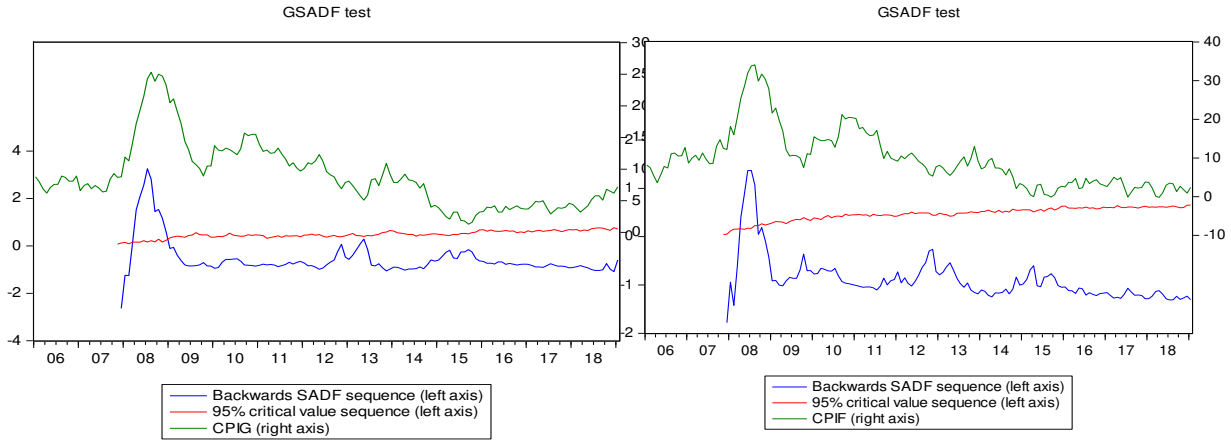
In Sensitive price index (SPI) a single bubble emerges from April 2008—November 2008. During this time period prices of basic commodities rose sharply for example daily food items; oil prices and other essential commodities prices were on a rising trend because overall inflation was increasing which was depicted in this index. The index value rose to 31.8 in August 2008 which was 7.6 in the preceding year for the same month which shows how abruptly prices of essential items which include food, electricity, oil and other necessities were on a rising trend (PES, 2008). The depreciating Pakistani rupee and rising oil prices shifted its impact on basic commodities price level which was the reason in rising SPI.

Figure 1 shows the overall behvior of series and the emergence and collapsing of single as well as multiple bubbles during the whole sample period pictorially. To locate a specific bubble, the calculated value of the Backward SADF is compared with the 95% critical value and when it exceeds the corresponding critical value, a bubble emerges and when it becomes smaller than the critical value the bubble pops out. So, the graph clearly specifies

the starting and ending of a bubble. The encouraging fact of this approach is that multiple bubbles can be easily specified, and one can easily date stamp bubbles.

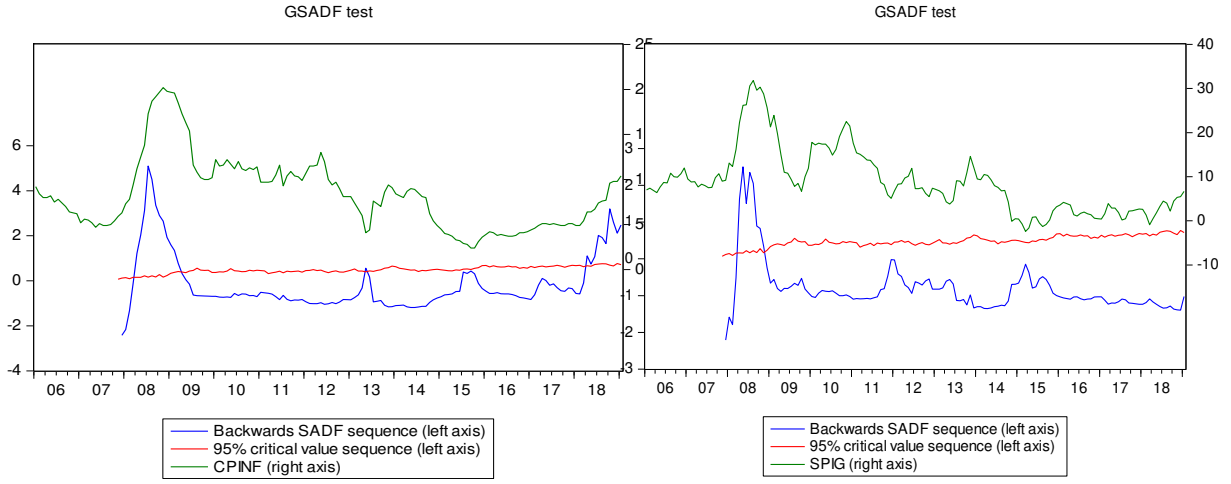
A comparison of current findings with the existing studies previously being done on inflation to detect bubbles shows mixed results. See for example, Funke et al. (1994) basing the analysis on the standard ADF test, finds the evidence of bubbles during the Poland hyperinflation while Barbosa and Filho (2015) using the same ADF approach for Brazil hyperinflation period reject the presence of bubbles. Arize (2011) tests the stationary property of inflation rates for African countries and suggest that these are non-stationary. Liu et al. (2017) findings for China's CPI suggest the existence of bubbles using GSADF. It is important to note that except Liu et al. (2017), all other studies discussed above make use of conventional ADF test to detect bubbles and hence their findings are questionable.

Figure 1: Date Stamping (Jan 2006—Jan 2019)



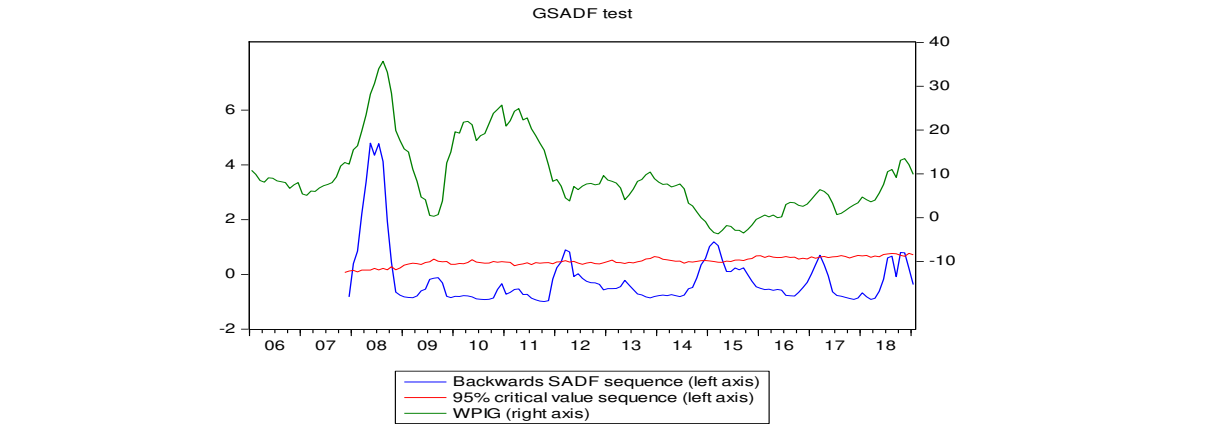
(a): Date stamping for CPIG

(b): Date stamping for CPIF



(c): Date stamping for CPINF

(d) Date stamping for SPI



(e): Date stamping for WPI

5. Conclusion and Policy Implications

In 2008 World witnessed global financial crisis world leading to a rise in inflation rates and food prices. Pakistan also faced a high inflation rate in 2008 where it went beyond 20%. Thus, it is essential to scrutinize whether huge rise in inflation is due to the fundamental factors or there is an exuberant behavior in inflation price indices. Pakistan being a developing nation and a high inflation rate is a major macroeconomic concern because most of the its population falls in the low-income category. Thus, rising inflation hurts the not only the poor segment of society but also the middle-income earners. Therefore, it is very important from a policy point of view, to detect bubbles in the inflation series. In context of Pakistan, five major price indices are available including consumer price index general, food and non-food, whole sale price index and sensitive price index.

The present paper takes a lead and addresses the issue of detecting bubbles in all price indices for Pakistan. The empirical analysis is carried out using latest available monthly time series data from Jan 2006 till Jan 2019 for Pakistan. The results are obtained by employing recently developed state or art approach for detection of multiple bubbles the (GSADF) approach. The empirical results suggest that all five indices experience a bubble in 2008.

There are several plausible reasons for the existence of bubbles in inflation series. As Pakistan's one fourth of imports are directed to oil and gasoline related products which are essential for every sector of the economy to run its operations, hence rise in global oil prices hurt the masses and businesses both. Secondly, any event like weather or any global event which can cause a rise in food prices should be addressed by the government. Thus, the government should have enough inventory in stock in case of any unforeseen event which can result in supply shortage and may cause a rapid rise in food prices.

Some key policy implications are as follows:

First: Due to the supply bottle necks or in case of floods, leads to shortage of supply of food items which results in a hike in prices and can resultingly form a bubble. This can be coped with serious efforts attributed to stock maintenance of essential food items.

Second: Whenever a rise in global oil prices is seen it immediately causes a rise in domestic oil prices and can form bubble. Thus, the dependency on foreign oil and petroleum related products should be reduced. This can be done by exploring these resources within the country as major import bill is directed to petroleum products.

Third: Sudden large fluctuations damage the economy as uncertainty starts to prevail when Pakistani rupee (PKR) value constantly fluctuates. This can be avoided by adopting a managed exchange rate policy.

Fourth: If state bank feels it should depreciate currency as it is required because Pakistan carries a trade deficit, so according to Pakistan's global trade position gradual depreciation policy should be adopted and should try to avoid sudden huge depreciations as it was done in 2008 and recently in 2018. Depreciating the currency brings inflation as economy is import based.

Fifth: Government of Pakistan should reduce its fiscal deficit to lower its excessive printing of money to finance its deficit, which results in inflation. Further Government should address those macroeconomic factors which cause sudden hike in prices and can result in bubble formation.

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