



Testing Multi Bubbles for Commodity Derivative Markets: A Study on MCX

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Abstract: Due to their volatility differences, yield differences and low correlations with equity markets, metal futures are held for diversification in the international investors' portfolios. Beginning with dot.com bubble and following global crisis, the mutual movement of equity markets caused investors to canalize alternative investment vehicles. The study aims to investigate if there are bubbles in metal futures in The Multi Commodity Exchange of India Limited (MCX) related the period beginning from January 2010 to August 2017 for copper, lead, nickel and zinc; and March 2010 to August 2017 for aluminum in a weekly data range. Using Sup Augmented Dickey Fuller (SADF) and Generalized Sup Augmented Dickey Fuller (GSADF) tests, no evidence on bubble could be found in any metal market in the used MCX sample. The precious metal markets are out of the sample because of their relatively high volatility.

Keywords: Bubble, Commodity Market, Metal Market, SADF, GSADF

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1. Introduction

For emerging economies, commodity derivatives markets have a significant place in the world economy, such as the future price determination and hedging, as well as the transfer of developed market characteristics and the development of the local financial infrastructure. On the other hand, due to their volatility differences, yield differences and low correlations with equity markets, metal futures are held for diversification in the international investors portfolios (Arouri et al., 2013; Arouri & Nguyen: 2010; Conover et al., 2010; Daskalaki & Skiadopoulou, 2011; Hammoudeh et al., 2013.) Beginning with dot.com bubble and following global crisis, the mutual movement of equity markets causes investors to canalize alternative investment vehicles such as commodity based derivatives. The growing interest of investors in commodity derivative markets may also lead prices away from the random walking process.

The separations of financial assets from random walking process called price bubble, and also expressed as the separation of a financial asset from its real value. Durability, scarcity and common beliefs associated with the behavioral finance are the three main actors cause price bubbles (Tirole, 1985). While the price bubbles mostly have been seen in financial assets and real estate, the first historical example of price bubble is Tulipmania. In the 1630s, the Dutch people devoted themselves to tulip cultivation and almost all of the arable fields were turned into tulip gardens. At the beginning of 1637, Semper Augustus was sold to the 10,000 Guilder. 10,000 Guilder could be paid by all but a few dozen of people in the Netherlands and coinciding with the price of the most beautiful houses in Amsterdam (Dash, 1999). In 20th century, real estate bubbles took place in US., Switzerland and Japan. While the real estate bubble is recognized in US, investors began to interest with the equity market. This interest caused another anomaly in financial markets that

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rapidly rising New York Stock Exchange fell 12.8 % on October 24, 1929. In late 1990s, the interest on US internet based companies stocks has been seen as rapid rise. This rapid rise collapsed in 2001. Finally, the last big bubble effected whole world economy is Mortgage crisis in 2008.

In this research investigating the existence of financial asset bubbles, commodity markets are selected as sample. The need to reduce the problems of the risky, unpredictable and unstructured agricultural industry has raised the need for the development of today's commodity derivatives. Agricultural commodity markets have a very complex mechanism involving farmers, farm owners, processors, distributors, packers, wholesalers and retailers. Moreover, it is difficult to manage risks such as extreme weather changes in agriculture, disease, natural disasters and government policies. The products that are most demanded in the world economy and whose prices are discussed are undoubtedly energy commodities. Beyond being the driving force of trade and industry, energy products that meet the needs of households are essential today in all areas of life. Firms which demand any amount of energy are at significant risk of changing prices. There are many common expectations of trading parties in the purchase and sale of any physical commodity in world trade. Expectations such as credibility, timeliness, honesty and flexibility lead to the standardization of the trade.

The use of commodity derivatives in terms of businesses leads to increased competitive advantage and profitability by using various price strategies. Enterprises using commodity derivatives in the supply of raw materials can fix production costs. Unpredictable, frequent and large fluctuations in commodity prices lead to managerial difficulties and costing problems when using these items in manufacturing enterprises, where commodity derivatives are not used without cost estimates.

Most of the transactions carried out in today's derivative markets are based on financial investment. Transferring information for future prices to all investors is an important function of futures markets. Those who collect and analyze information about the future state of the world economy will obtain returns on their investment in this information. In the absence of a futures market, investors use the information they analyze to determine the spot price for the following period. The fact that informed investors have different expectations for the future price will also cause the investor with knowledge to get a return on the market. In advanced derivative markets, the future prices are made known to all investors and the information of the investor who has knowledge is transferred to the investor who does not have knowledge.

The interest among commodity markets and commodity derivative markets encountered with speculative movements like other investment instruments over time. As exemplified in the literature part, bubbles are found in many types of commodity markets as precious metals (Baur & Glover, 2012), agriculture (Diesteldorf et al., 2016) or oil products (Su et al., 2017). In the study, the bubbles in non-precious metals as aluminum, copper, lead, nickel and zinc are detected in a growing and known commodity futures market: The Multi Commodity Exchange of India Limited (MCX). India, which have a growing share of the world economy with features such as rich natural resources, labor force, have an important place among the world's derivative markets too. National Stock Exchange of India is the 2nd derivative market with it's 2.47 billion contracts' volume and MCX is the 20th derivative market with it's 0.20 billion contracts' volume in 2017 in the world.

These selected group have the most basic inputs of industrial production. They are used in vehicles, military applications, packaging, construction, electrical-electronics, chemical and steel industries.

2. Literature

Different types of tests have been developed to clarify the bubbles beginning with variance bound tests (Shiller, 1981) and runs test (Santony, 1987). At the same time, there are numerous studies in the literature describing the suddenly big movements in financial asset prices and real estate prices (Bettendorf & Chen, 2013; Phillips, Shi & Yu, 2015, Escobari & Jafarinejad, 2015; Korkmaz, Erer & Erer, 2016) However, the number of works on bubbles related with spot or futures commodity prices is limited. Especially GSADF test used in the study is a very new model developed by Philips et al. in 2015.

Gilbert (2009), Gutierrez (2013), Areal et al. (2014), Etienne, Irwin, and Garcia (2014), and Diesteldorf et al. (2016) test bubbles in agricultural commodity markets. Gilbert (2009) and Gutierrez (2013) find bubbles for four markets. Markets as fruits, meat and seafood have no evidence on bubbles in Areal, Balcombe and Rapsomanikis (2014). Etienne et al. (2014) find evidence on 10 of 12 commodities. Diesteldorf et al. (2016) use GSADF test to investigate the presence of bubbles in ten agriculture commodity prices. One to three bubble periods are found for six types of commodities in their study.

Gold is a valuable investment instrument, beyond being an industrial asset. Bubbles in gold prices are analyzed by Baur and McDermott (2010), Baur and Glover (2012) and Long et al. (2016). They all find evidence on the bubbles in gold prices. The other type of commodities which have importance in the world economy are energy products such as crude oil and natural gas. Su et al. (2017) find six bubbles in oil in a 21 years period ending 2016.

In recent years, studies in the literature have included bubble analysis in similar metal market samples as the sample used in this study. Ferretti et al. (2015) detect bubbles on London Metal Exchange (LME) for six non-ferrous metal prices. In another study, the global iron ore prices beginning from 1980 to 2016 are analyzed by GSADF in Su et al. (2017). Four different bubbles in the years 2005, 2006, 2007 and 2008 are found in the model.

3. Data and Model

MCX is a commodity derivatives exchange in India which started operations in November 2003. MCX is not only an important metal and energy derivatives exchange, some agricultural derivatives as black pepper, cotton, crude palm oil, and mentha oil are also have being traded. In the study, metal futures closing prices used begin from January 2010 to August 2017 (398 observations) for copper, lead, nickel and zinc; and March 2010 to August 2017 (389 observations) for aluminum in a weekly data range.

3.1. Sup Augmented Dickey Fuller Test

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

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

$d = \text{constant}$,

$T = \text{sample size}$,

$\eta > \frac{1}{2}$

The recommended empirical regression model for bubble detection in formula (1) above includes an intercept but no fitted time trend in the regression. Suppose a regression sample starts from the r_1^{th} fraction of the total sample and ends at the r_2^{th} fraction of the sample, where $r_2 = r_1 + r_w$ and r_w is the (fractional) window size of the regression. The empirical regression model can be written as follows:

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

$k = \text{lag order}$,

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

$T_w = [Tr_w] = \text{Number of the observations in the regression}$

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

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

r_w = window size

window size expands from r_0 to 1.

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

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

3.2. Generalized Sup Augmented Dickey Fuller Test

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

$$GSADF(r_0) = \sup_{\substack{r_2 \in [r_0, 1] \\ r_1 \in [0, r_2 - r_0]}} \{ADF_{r_1}^{r_2}\} \tag{3}$$

Including an intercept in the regression model and the null hypothesis is a random walk without drift (i.e. dT^{-n} with $n > \frac{1}{2}$ and constant d), the limit distribution of the GSADF test statistic is can be written as follows:

$$\sup_{\substack{r_2 \in [r_0, 1] \\ r_1 \in [0, r_2 - r_0]}} \left\{ \frac{\frac{1}{2}r_w[W(r_2)^2 - W(r_1)^2 - r_w] - \int_{r_1}^{r_2} W(r)dr [W(r_2) - W(r_1)]}{r_w^{\frac{1}{2}} \left\{ r_w \int_{r_1}^{r_2} W(r)^2 dr - \left[\int_{r_1}^{r_2} W(r)dr \right]^2 \right\}^{\frac{1}{2}}} \right\} \tag{4}$$

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

The asymptotic GSADF distribution depends on the smallest window size r_0 . If total number of observations (T) is small, r_0 needs to be large enough to ensure there are enough observations for adequate initial estimation. If T is large r_0 can be set to be a smaller number, thus the test does not miss any opportunity to detect an early explosive episode (Phillips, Shi and Yu (2011)).

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

4. Empirical Results

The empirical analysis is composed of three steps. In the first step, the descriptive characteristics as normality and skewness of series are identified. Secondly, the traditionally unit root model ADF (Augmented Dickey Fuller) is used to test the nonstationarity of the series. Lastly, the bubble in prices are analyzed in Eviews 9 programme by the Sup Augmented Dickey Fuller Test (SADF) and Generalized Sup Augmented Dickey Fuller Test (GSADF).

The descriptive statistics of the variables are shown in Table 1. While copper price and nickel price skewed to the left (left-skewed); the prices of aluminum, lead and zinc skewed to the right (right-skewed).

The kurtosis of the futures price series of aluminum, copper and nickel are less than 3, then the series have lighter tails than a normal distribution. These series have light-tailed distributions. On the other hand, the kurtosis of the series lead futures prices and zinc futures prices are greater than 3, then they have heavier tails than a normal distribution. These series have heavier-tailed distributions.

Table 1. Descriptive Statistics

	ALUMINUM	COPPER	LEAD	NICKEL	ZINC
Mean	109.8645	389.0437	119.0190	880.8905	121.6814
Median	109.2000	401.8750	118.3500	904.7000	113.3750
Maximum	131.2000	475.4000	165.1000	1312.500	200.8000
Minimum	88.65000	294.2500	75.45000	534.1000	78.30000
Std. Deviation	7.989995	45.77181	15.25960	176.5652	25.20131
Skewness	0.226836	-0.357586	0.234767	-0.100498	1.129806
Kurtosis	2.905379	2.017216	3.220565	2.316451	3.639984
Jarque-Berra	3.481091	24.49915	4.462766	8.418333	91.46416
Probability	0.175425	0.000005	0.107380	0.014859	0.000000
Sum	42737.30	154839.4	47369.55	350594.4	48429.20
Sum. Sq. Dev.	24769.93	831738.4	92442.38	12376580	252137.2
Observations	389	398	398	398	398

In the second step, to test the nonstationarity, the regular ADF test (Dickey Fuller, 1981), is applied to the series. The unit root tests of the variables are shown in Table 2. Except lead in the test with trend and intercept, all results in ADF tests obtain Akaike (AIC) information criteria higher than the critical values. As a result of the test, we failed to reject the hypothesis that the series are stationary.

Table 2. The Results of the Unit Root Tests ADF

	ADF								
	Akaike (Intercept)			Akaike (Trend and Intercept)			Akaike (None)		
	Lag	T_stat	Prob.	Lag	T_stat	Prob.	Lag	T_stat	Prob.
Aluminum	0	-2.790451	0.0605	0	-3.241889	0.0779	4	0.476205	0.8174
Copper	0	-2.480169	0.1211	0	-2.594846	0.2830	0	0.039461	0.6948
Lead	0	-2.319009	0.1665	0	-3.793981	0.0178	0	0.130379	0.7231
Nickel	1	-1.588555	0.4875	0	-3.307013	0.0666	1	-0.544288	0.4809
Zinc	0	-0.078097	0.9495	0	-2.267181	0.4505	0	1.021134	0.9195
Asymptotic critical values									
1%		-3.446608			-3.981343			-2.570800	
5%		-2.868601			-3.421183			-1.941623	
10%		-2.570597			-3.133343			-1.616164	

In the third step, the price bubbles in MCX commodity markets identified with SADF and GSADF tests. The results of SADF and GSADF tests are given on Table 3. The statistics are compared with the critical values obtained from the Monte Carlo simulation with 1000 replications for each observation.

Table 3. Test Statistics for SADF and GSADF

	Test Stat.	<i>Finite Sample Critical Values</i>		
		90%	95%	99%
ALUMINUM	Window size: 39			
SADF	-0.162794 (0.6980)	1.239582	1.581463	2.002917
GSADF	0.312490 (0.9990)	2.007932	2.235417	2.924801
COPPER	Window size: 40			
SADF	0.595962 (0.3070)	1.195182	1.448958	2.108712
GSADF	0.932452 (0.7070)	2.014128	2.265443	2.924275
LEAD	Window size: 40			
SADF	-0.997800 (0.9460)	1.195182	1.448958	2.108712
GSADF	1.354989 (0.4260)	2.014128	2.265443	2.924275
NICKEL	Window size: 40			
SADF	-0.996898 (0.9460)	1.195182	1.448958	2.108712
GSADF	1.853371 (0.1470)	2.014128	2.265443	2.924275
ZINC	Window size: 40			
SADF	-0.656167 (0.2740)	1.195182	1.448958	2.108712
GSADF	1.885613 (0.1380)	2.014128	2.265443	2.924275

Critical values are based on a Monte Carlo simulation

The figures 1-5 show the futures prices in green, critical values in red and the calculated sequences in blue. Generally, the areas above the red critical values of the blue line, indicate bubble possibilities.

While the blue line does not reach the critical values in both analyzes in the aluminum contract, two analyzes for Copper and Zinc have caught upside price movements in similar places. At the Copper contract, speculative movements are observed at the end of 2010, at the beginning of 2011, and Zinc in 2016. However, the test results in Table 3 do not identify these movements as price bubbles for the whole period. The test statistics for Copper are 0.60 (SADF) and 0.93(GSADF); for Zinc 0.27(SADF) and 0.14 (GSADF). Speculative movements are captured by GSDF test in Lead prices in 2016 and Nickel prices in 2014. At the same time, these movements could not be separated from the random process according to the test results in Table 3. The test statistics for lead are 0.95 (SADF) and 0.43 (GSADF), and for Nickel -1 (SADF) and 1.85 (GSADF). According to the figures, the speculative attacks in Lead, Nickel and Zinc do not take long periods, but the speculative attack on Copper takes a long period. Although the test results in Table 3 do not value this attacks as bubble, the period beginning from September 2010 to February 2011 is clearly shown as bubble.

Figure 1. SADF & GSADF for Aluminum

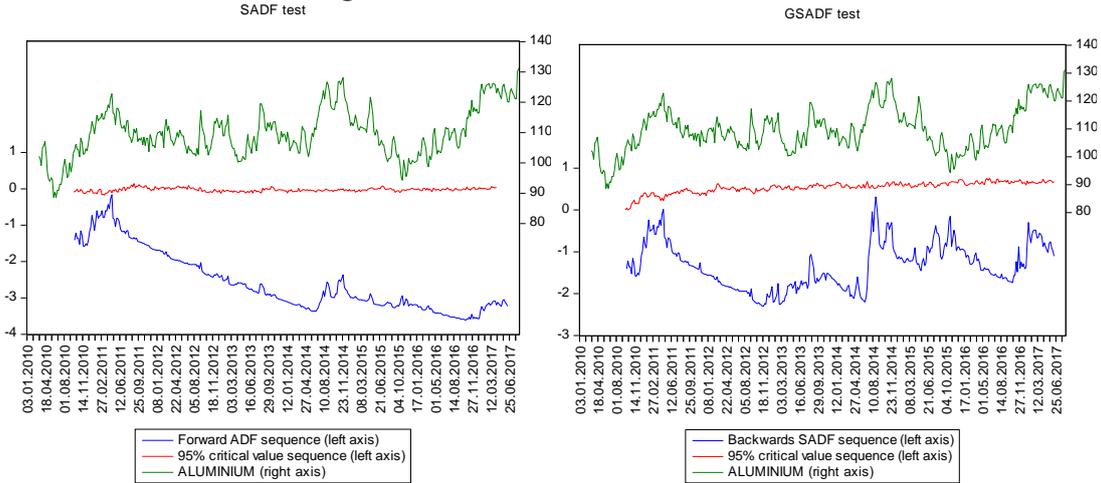


Figure 2. SADF & GSADF for Copper

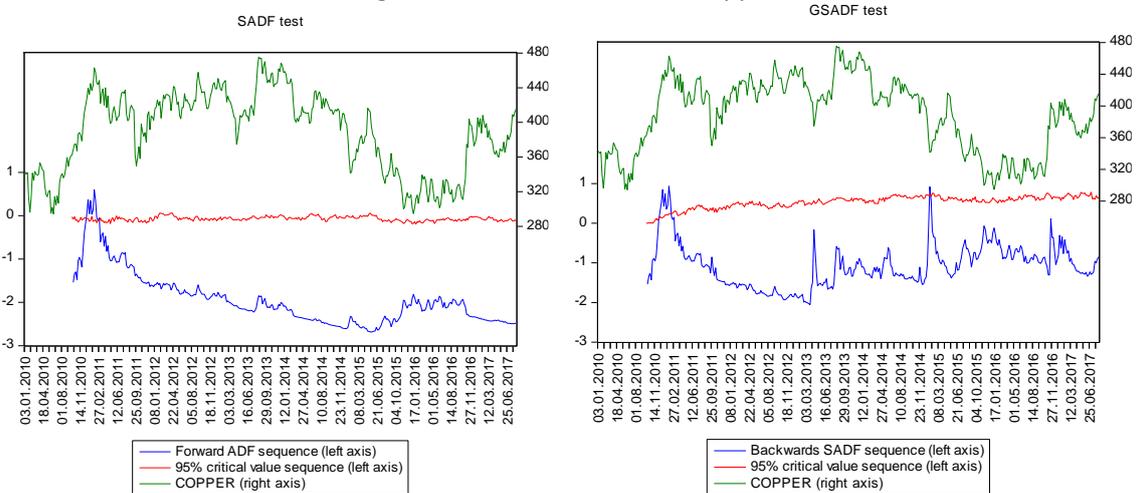


Figure 3. SADF & GSADF for Lead

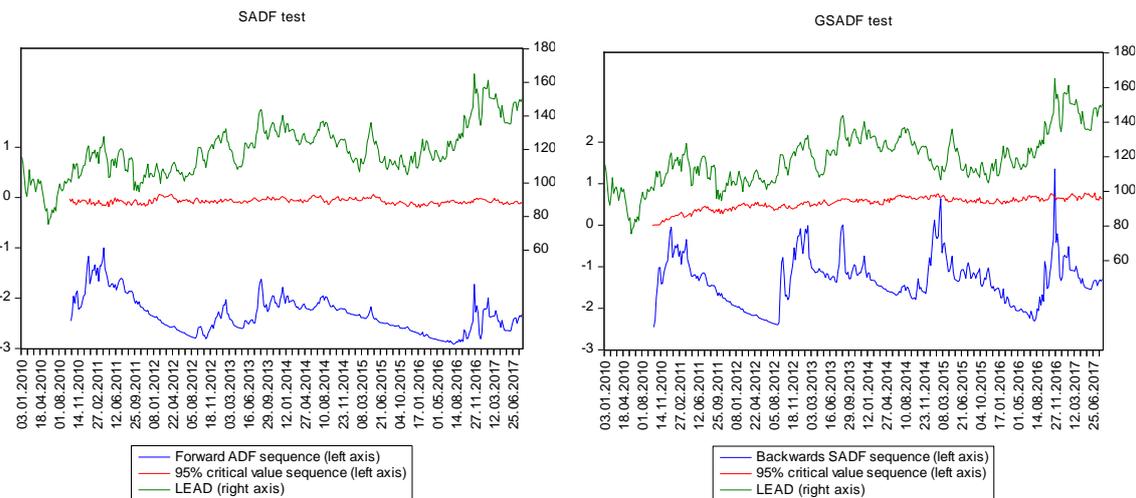
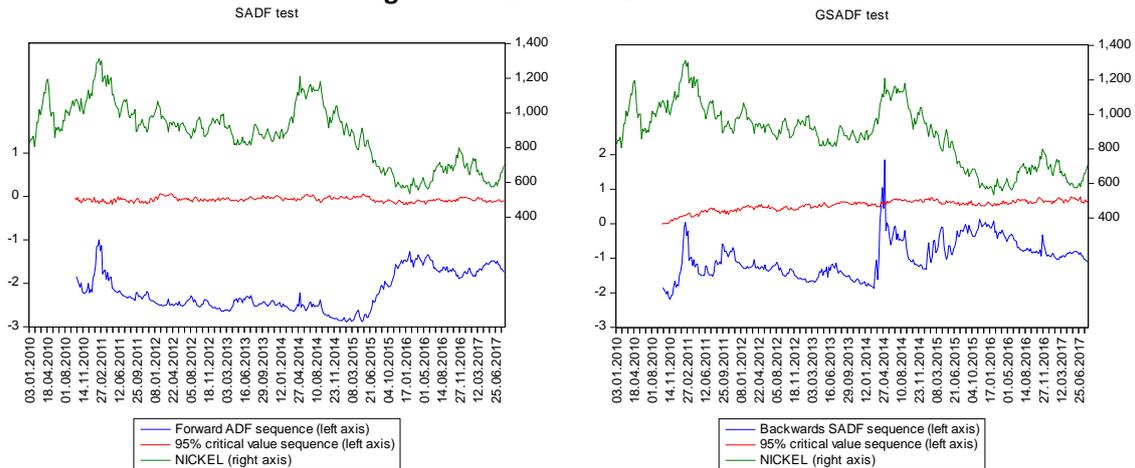
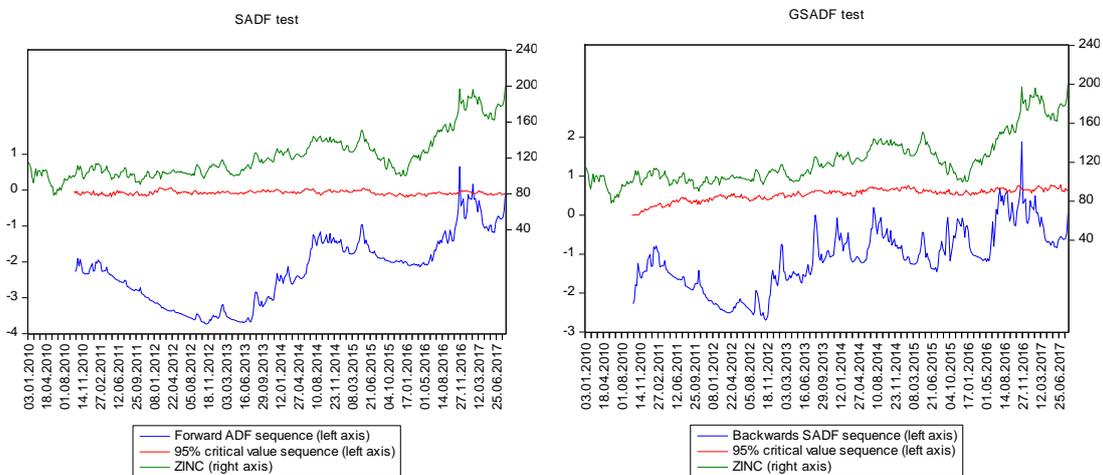


Figure 4. SADF & GSADF for Nickel**Figure 5. SADF & GSADF for Zinc**

5. Conclusions

Most of the transactions carried out in today's derivative markets are based on financial investment. Due to their volatility differences, yield differences and low correlations with equity markets, metal futures are held for diversification in the international investors' portfolios. The mutual movement of equity markets cause investors to canalize alternative investment vehicles. In the study, the bubbles in non-precious metals futures prices as aluminum, copper, lead, nickel and zinc are detected in MCX. The period beginning from January 2010 to August 2017, for copper, lead, nickel and zinc; and the period beginning from March 2010 to August 2017 for aluminum in a weekly data range are analyzed.

Using SADF and GSADF tests, excessive price movements are found for copper, lead, nickel and zinc. Moreover, the period beginning from September 2010 to February 2011 is shown as bubble in copper futures market in India. As well as in other financial asset prices in the global financial markets, the similar price changes in commodity derivative markets are shown in different markets in the same periods. While the prices in other markets are examined, the similar rises and declines are clearly seen in all markets for the same commodity derivative instrument. In other words, the bubble identified in copper futures market in MCX in this study, and the speculative attacks in other commodity futures contracts in the sample are already exist in the US, European and other markets too. As a result, beyond determining asset bubbles, associating these bubbles with the Indian economy does not correspond to the reality of globalized financial markets.

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