Price Bubble in Selected ASEAN Agricultural Exports: An Application of the Generalized Supremum Augmented Dickey Fuller

Caramugan, Karlo Martin and Bayacag, Purisima

School of Applied Economics-University of Southeastern Philippines

August 2016

Price Bubble in Selected ASEAN Agricultural Exports: An Application of the Generalized Supremum Augmented Dickey Fuller

Karlo Martin C. Caramugan and Purisima G. Bayacag

Abstract

Typical economic theory suggests that price volatility especially the upswings in food price in the commodity market is driven by market fundamentals, i.e., the demand and supply for the commodity. The recent behavior of the world food commodity prices has experienced several large spikes with the 2007-2008 episodes as the most dramatic. The prolonged rise of global commodity prices which peaked in mid-2008, had been seen to fall sharply and bottomed out in early 2009. This price increase which strongly deviated from its intrinsic value was characterized as explosive which indicates price bubble.

The study investigated the existence of a price bubble in selected key ASEAN exports i.e. rice, rubber and palm oil. Using the generalized supremum augmented Dickey-Fuller (GSADF), results reveal multiple bubbles from 1980-2015. Furthermore, through descriptive correlation, these price bubbles had observed to form with some important local and international economic and political scenarios at the backdrop. With these findings, it is recommended that key exporting countries cooperate in creating an international supply management system to ensure the sufficiency and sustainability of the supply of the key agricultural products. Furthermore, it is recommended to improve current market information systems to reduce price volatility. ASEAN countries can reduce the price transmission from international markets through the use of trade controls and buffer stocks. In the longer run, exporting countries need to invest more in their agricultural sector, making it more productive and efficient, thus will make food more affordable for the poor and reduce price volatility.

Keywords: Fundamental Price**,** GSADF, Price Bubble.

Introduction

Typical economic theory suggests that price volatility especially the upswings in food price in the commodity market is driven by market fundamentals, i.e., the demand, supply and the stocks for the commodity or inventory. The recent behavior of the world food commodity prices has experienced several large spikes with the 2007-2008 episodes as the most dramatic (Etienne et al., 2013). The prolonged rise of global commodity prices which peaked in mid-2008 had been seen to fall sharply and bottomed out in early 2009. From then, the global commodity prices was seen rising again and accelerating in 2010 (Yasunari, et al., 2011; Varadi, 2012). In 2012, the United Nations (UN) blamed the continuous food price increase of 2008 on international trading of agricultural commodities rather than actual food stocks in the physical markets (UNCTAD, 2012). This global phenomenon of price boom and subsequent bust became the center of attention of researchers, as the prices of the commodities seemed to deviate substantially from market fundamentals. This price increase which strongly deviated from its intrinsic value was characterized as explosive which indicates price bubble.

The concept of price bubble is not new having been largely used in the financial market. In the financial market, a bubble exists when the market price of an asset exceeds its price determined by fundamental factors by a significant amount for a prolonged period. An asset buyer is willing to pay a price above fundamentals because, in addition to the asset, the buyer obtains an option to sell the asset to other traders who have more optimistic beliefs about its future value.

The study of price bubbles may be adopted to commodity markets to understand the explosive nature of agricultural commodity prices. Similar to the financial concept, the Commodity Futures Trading Commission (CFTC) defines a commodity price bubble as a rapid run-up in prices caused by excessive buying of the commodity that is unrelated to any of the basic, underlying factors affecting the supply and demand for a commodity. Speculative bubbles are usually associated with a “bandwagon” effect in which speculators rush to buy the commodity before the price trend ends, and an even greater rush to sell the commodity when prices reverse. According to Stiglitz (1990), when the fundamental factors do not seem to justify such a price, then bubble exists.

The price mechanism of agricultural commodities is complex. Economists have continued to debate on the causes of the recent price exuberance especially during the 2007-2008 period. Some economist and researchers have identified several factors which may have contributed to the price increase. The Asian Development Bank (ADB) reported in 2011 that the global price increase phenomenon was attributed to structural and cyclical factors. These factors include the fall in the global stockpile of agricultural commodity whereby demand seemed to be increasing as a result of growing world population and strong income growth in emerging economies (ADB, 2011). The competing use of food grains such as corn to produce biofuel also contributed to the price increase. Furthermore, the increasing demand, predominantly through the economic rise of emerging economies may have pushed global food prices up (Whal, undated). Alongside with this, other supply-side factors include the conversion of agricultural lands, low crop yields, rising input costs and neglecting agricultural technology and infrastructure investments. Yet, some economists and policymakers opened up a new perspective on the causes of these price increases. Economists increasingly agree that speculation exists. Speculation occurs in such a way that people have different perceptions of where supply and demand are at present and how supply and demand will change in the future (Parcell and Pierce, undated). A commodity price bubble exists because of speculation in the futures market, a case where there is an excessive expectation of future price increase of a particular commodity (de Oliveira and Almeida, 2014). Market actors, such as traders, producers and processors, continue to engage in speculation and trading in the futures market as this enables them to protect themselves against short-term price volatility through "hedging." With hedging, buyers of the commodity are safeguarded against sudden price increases while sellers against sudden price fall. Futures markets serve the intertemporal choice of end users by trading expectations on supply and demand patterns of a particular commodity (Valiante, 2013).

Another objective of commodity speculation, aside from hedging, is to profit from a future difference in the prices of assets. If, for example, a farmer does not place his crop on the market as soon as it is harvested, but hoards it for a couple of weeks because he expects that the price will be higher, this is speculation. No real, additional value is created and there is merely speculation on a higher price. If a lot of farmers do this simultaneously, a speculative bubble is formed, i.e. the price of the crop increases because the hoarding causes supply shortages (Wahl, undated).

Moreover, the existence of index funds allow commodities to be traded in the futures market similar to any financial assets such as real estate, stocks or bond. Agricultural commodities usually accounts for 10-20 % of a particular index. Lately, commodities had been increasingly regarded as an investable asset class, believed to have good diversification benefits, low correlations with stocks and bonds, and good hedging properties against inflation (Brooks et al., 2014). The motivation on portfolio diversification considerations, made investors turned to commodities as an investment alternative to asset classes. Thus financialization of commodities exists. In early 2000s, investors benefitted from the substantial rises in the prices of commodities and the trading profits made by those who bought early in the upswing drew in further waves of speculators. For example, during the 2007-2008, it was observed that the global market was experiencing a capital flight from the asset market to the commodities market. Driven by risk aversion, investors saw the need to diversify their of portfolio assets. The investors have entered the commodity markets, primarily mineral oil, but also agricultural commodities. Agro-futures were bought expecting continuing increasing prices, so that they could be sold later at a profit. When institutional investors turned to the commodity markets, this affected the price trends of the agricultural commodities sold in the futures market thereby pushing the creating pressure for the demand for futures contracts. In 2007, the trade in agricultural futures and options warrants increased by 28.6% for energy and by 29.7% for industrial metals while the strongest rise occurred in agricultural derivatives, which increased by 32% (UNCTAD, 2008; Wahl, undated). The price increase in derivatives caused a rise also in the spot prices. Buyers on the spot markets bought more ahead to put in stock for fear of further price increases. This increased demand and caused an upward pressure on prices.

Rationale

Economic literatures on the study of financial bubbles have been numerous as compared to fewer investigations conducted in the context of commodities (Brooks et al., 2014). The 2008 international food price increase provided an avenue where the analysis of bubbles may be explored in the context of commodities. Consumers in many developing countries in 2008 were alarmed by the increases in the cost of their staple foods and demanded some strict measures and policies to address this issue (Eugenio et al., 2009). It is undeniable that prices are volatile and can rise quickly over a short period of time. However, the causes are not clear whether this is due to speculation or price dynamics caused by fundamental factors namely, quantity supply and demand (Brooks et al., 2014). In any case the rapid commodity price increase and subsequent fall have serious consequences.

Commodities are core inputs to the production process or are intermediate goods and the continuous increase in the price of these commodities post real production costs (Brooks et al., 2014). Ultimately, increase in the price of these core inputs will eventually cause consumer good prices to increase which will stimulate inflation. The inflation caused by increasing commodity prices accounts for up to a third to more than half of the nominal rate of inflation in developing countries particularly in Asia (Wahl, 2008). More importantly, rapid changes in agricultural commodity prices have immediate effects on income, welfare and decision-making of producers, agents along the supply chain and consumers as well as the trading positions of countries (Balcombe, 2009).

Meanwhile, price upswings also have serious implications to the consumers especially the poor. As food prices increase, the monetary cost of achieving a fixed consumption basket increases (Hoyos and Medvedev, 2009) thereby reducing consumers' welfare. In an industrial country for example, the portion of expenditure for food of a typical household budget amounts to 10-20 percent, whereas for the least developed countries, it accounts for 60-80 percent of their expenditure (FAO, 2008; Wahl, 2008). Food price increase may lead up to food crises which post a problem for the vulnerable poor. Therefore, there are concerns that food crises may plunge more people into poverty, in addition to exacerbating the hunger and malnutrition of those who are already poor (Heady and Fan, 2008; Mansado and Prado, 2014). Also, those who were barely above the poverty line may have slipped back into poverty once again (Cachia, 2014).

Furthermore, price shock worsen the ability to implement social safety programs (e.g. Conditional Cash Transfer or CCT) for the vulnerable poor population (Areal et al., 2014) because the amount that the government doles-out to the poor population is hinged on prevailing prices of basic commodities and staple food. High prices undermine poverty reduction and human development gains achieved for a long period of time (Cachia, 2014).

Price bubble also poses a risk especially for Third World farmers who are net consumers rather than net producers or typically producing at the subsistence level. In some cases, these farmers attempt to minimize their exposure to price risk by growing their own food, avoiding new technologies and diversifying their activities i.e. planting different crops (Kurosaki and Fafchamps, 2001). Risk avoidance inhibits gains from specialization, that is, instead of investing more on farm productivity, farmers would spend more on income-stabilizing strategies. In addition, as the price of a crop increases, it drives farmers to increase their acreage for that specific crop and further increase their acreage even more as the selling price of the commodity continues to increase. But bubbles in essence post uncertainty as continuous increase in price is often followed by a price collapse and these results to misallocation of valuable economic resources.

The concept of commodity bubble has a great importance especially that the possible negative effects of a bubble in an economy may be catastrophic. The role that the commodities play in the economy is complex, ranging from consumption and inputs to manufacturing and trade. The issue on food price increase and volatility is of critical importance for two (2) main reasons. First, the share of food in the typical consumption basket is larger in developing countries including the Philippines, Thailand, Malaysia and Indonesia compared to advanced economies. As a result, the pass-through of food prices in international markets to headline inflation tends to be higher in these economies. Second, there is greater potential that changes in commodity prices will affect their terms of trade and trade balances, given relatively larger shares of commodities in both imports and exports (IMF, 2011). Thus timely testing for the existence of such bubbles is relevant. With the unpredictability of commodity price formation in case of bubbles, the investments in the production and consumption of the commodities are at risk. Also, countries and firms which are depended in the commodities for inputs to production and for consumption bear the problem of rapid price increase and its subsequent collapse post a problem in planning, inventory and preparations. Three commodities have such significance, especially in the individual ASEAN countries particularly Singapore, Malaysia, Thailand, Indonesia and the Philippines. These commodities include rubber, palm oil, and rice. Domestically, these commodities are the top agricultural exports of the respective ASEAN countries. Globally, the domestic prices of these commodities are considered the benchmark prices. A benchmark price is the price per unit of quantity of a commodity traded in the international marketplace, set by the country that consistently exports the largest quantity or volume of the commodity or in a marketplace. The 5 ASEAN countries have a significant economic dependence on production, exportation and importation of these

4 commodities. For example, in 2010, the ASEAN region collectively exported 16.05 million tons of rice or nearly 49% of the world's total rice exports. Thailand topped the list of rice exporters not only in the region but also in the world, accounting for 30.63% of total world rice exports in 2011 (Clarete et al., 2013). While ASEAN remained to be a rice net exporter, the region also hosts the world's largest rice importers with total rice imports of 4.95 million tons in 2011, or 14.52% of the world's total rice imports.

Aside from rice, the region also supplies the majority of the natural rubber needs of the world. In 2013, Thailand remained the largest producer of natural rubber, accounting for 34% of global production equivalent to 4.1 MT, followed by Indonesia and Vietnam, accounting for 26% and 9% respectively (Kose et al., 2014). Meanwhile, palm oil is also an important agricultural export to some ASEAN countries. In 2015, among the top 10 palm oil producers in the world, 3 are from ASEAN with Indonesia producing about 30% of the world's palm oil supply, followed by Malaysia (21%) while Thailand is the 7^{th} top palm oil producer (2%). In terms of palm oil exports, Indonesia accounts for 52% of total palm oil exports which is followed by Malaysia at 39% while Thailand is 13^{th} on the list with exports accounted to 0.32% of the total exports.

Objectives of the Study

The study sought to investigate whether a price bubble exist in the major agricultural export commodities of selected ASEAN countries, i.e., Singapore, Malaysia, Thailand and the Philippines. Specifically, this study sought to:

1. empirically investigate the existence of price bubbles in the major agricultural exports of selected ASEAN countries using futures prices of rice, rubber and palm oil, and
2. determine the duration then date-stamp the exact starting and termination dates of price bubbles, and

Significance of the Study

Sound and appropriate policy decisions to address price upswings and volatility may only be as good as they are if there is a better understanding on the causes of such price spike. There is a particular interest to study the upward movement and the sudden decline of commodity prices and the underlying causes as these price increases have serious implications to the society in general. As a result of price exuberance, consumers, producers and governments are exposed to price risks. Therefore, there is a need to address the problem of erratic price increase. One possible solution is through a retrospective approach by determining the economic scenario and events prior to such price increase and a “red flag” alarm system may be adopted. Specifically, when a bubble is detected on a particular period, the knowledge on pre-bubble economic scenarios will serve as “triggering device,” hence allowing policy makers to foresee imminent price increase. Furthermore, minimizing potential economic loses is foremost in the study of bubble. In such case, the timely detection and diagnosis of a bubble is critically important. The study also serves as basis for the government to craft up-to-date policies and corrective measures in response to the price bubbles. Early detection will serve as a useful alert mechanism to market participants. Regulators concerned with practical policy implementation need to assess whether real time data provide evidence of price exuberance. Policy makers may assess the events which lead to the price increase and prevent the same thing to ever happen again. Traders and buyers can be guided on the position they need to take in the futures market in response on the level of commodity prices reflecting the market forces.

On the other hand, in the absence of a bubble where abnormal price movement is caused by supply-demand relationship the government can adopt measures to stabilize the price. These policy measures include access to market information, improvement in technology and infrastructure and other facilitating mechanisms that prevent the erratic movement of prices caused by supply-demand interaction. If the causes of such price exuberance is speculation which is happening in international scale, regulatory regime may be adopted. Finally, the study will serve as future reference for other researchers who are interested in the topic of speculate bubble.

Scope and Limitation

The study investigated the existence of price bubble in the three (3) major tradable commodities in selected ASEAN countries. The monthly data from 1980 to 2015 used in the study was sourced out from the International Monetary Fund (IMF) database. Though the price bubbles prior to the 2007-2008 trends is worth noting for, the study is, however, mainly interested in the roles of financial actors (e.g. speculators, small and large non-commercial speculative fund) whose trading activities gathered momentum only quiet recently as far back as only in 1990 (Gilbert and Pfuderer, 2013). Specifically, the study sought to investigate the existence of price bubbles in the futures prices of rubber, palm oil and rice. The study does not attempt to answer why bubbles exist or how and why it burst but rather provide a descriptive correlation between the bubble periods and the political and economic events prior to the bubble occurrence and its burst.

Theoretic Framework

The occurrence of price bubble in the commodity market was attributed by some researchers on the speculative activities in the market. Relevant theories in explaining such phenomenon includes the theory of Rational Commodity Pricing developed by Pindyck (1993) which is anchored in rational expectations model. Another set of theories which supports the existence of a price bubble are the Psychological Theories whose foundation can be traced back to John Maynard Keynes's "Animal Spirit". Other Psychological Theories include the Greater Fool Theory and the Extrapolation Theory, which also argues the innate tendencies of market actors to act irrationally. Generally, these Psychological Theories, as what Keynes claim, bring the idea that economic agents may act under irrationality causing distorted asset prices and therefore instability. The subsections of this chapter discuss the theories mentioned in detail (Jimenez and Vilella, 2011).

The Animal Spirit Theory

Keynes talked about the Animal Spirit Theory in his General Theory arguing against the fact of mathematical calculations being able to predict or measure the expected value of assets prices. The people supposed to be ignorant to form reliable estimates of present values of assets. Their ignorance leads to short-term trading, "speculation", rather than long-term trading. This short-run perspective often makes for instability. Keynes believed that actions induced by animal spirits were absolute irrational (Jimenez and Vilella, 2011).

Greater Fool

This theory associates the existence of a bubble to over-optimistic agents-the "fools" who buy overvalued assets and were aware that the existing price does not reflect the fundamental price and sells these assets at even higher prices to the other market agents (the greater fools). These greater fools have even higher (over-optimistic) expectations on the asset prices are willing to speculate with them. This cycle goes on until the bubble burst when there are no more fools willing to buy at the peak price (Jimenez and Vilella, 2011).

Extrapolation Theory

The extrapolation theory suggests that agents project future prices using historical data often believing that the same scenario would still exist and is going to repeat in the future under the same context (Jimenez, 2011). Thus, in a bubble, agents believe that prices will continue their past trend in the future. This comes from the rational behavior of investors to associate past returns on investment with future returns with the consequences of overbidding some risky assets in order to maintain and achieve the same past rate of return. However, a point is reached where returns are no longer positive and investors feel uncompensated for their risk the bubble bursts (Jimenez, 2012).

Rational Commodity Pricing Theory

The Rational Commodity Pricing Theory of Pindyck (1993) applied the present value model on rational commodity pricing. Rational commodity pricing is the case where the price of a commodity P_t is determined by the current and expected future payoffs (profit from the sale of the commodity) φ_{t+1}. Pindyk (1993) draws the analogy similar with the rational pricing of assets, such as stocks, and underlines that for a storable commodity, the stream or flow of payoffs φ_{t+1} is the convenience yield accruing to the owner of the inventory in terms of benefits related to the facilitation of processing, sales and avoidance stock-outs. The convenience yield is the resale value of any benefits that an inventory provide, including the ability to smooth production, avoid stock-outs and facilitate the scheduling of production and sales that accrues to the owner of the inventory and is directly analogous to the dividend on a stock (Pindyck,1993). The standard arbitrage condition is:

$$P_t = E_t\left[\frac{1}{(1+r)}(P_{t+1}+\varphi_{t+1})\right] \qquad (1)$$

where: P_t = current price of the commodity
r = discount rate
P_{t+1} = future price of the commodity
φ_{t+1} = stream of expected future payoffs

In addition, Equation 1 states that the price of the commodity today is the expected values of the discounted payoffs and its future resale price. Furthermore, assuming that arbitrage condition exist, allows the presence of a bubble as oppose to the non-arbitrage condition which associates price upswings solely to the fundamental or to intrinsic price of the commodity. Arbitrage is a scenario where a seller buys a commodity from market A and sells it to an identical market B on a higher price (knowing that in market B the commodity may be sold at a higher price).

Moreover, for Equation 1 to hold for the indefinite horizon, T, stocks should be positive and no stock-outs occur such that sellers have intentional inventory as buffer. The forward iteration of Equation 1 is:

$$P_t = E_t\left[\frac{P_{t+1}}{1+r} + \frac{P_{t+2}}{(1+r)^2} + \ldots + \frac{P_{t+k}}{(1+r)^k} + \frac{\varphi_{t+1}}{1+r} + \frac{\varphi_{t+2}}{(1+r)^2} + \ldots + \frac{\varphi_{t+k}}{(1+r)^{T-k}}\right]. \quad (2)$$

Generalizing equation (2):

$$P_t = \underbrace{E_t\left[\sum_{i=1}^{T-1} \frac{1}{(1+r)^i}(\varphi_{t+1})\right]}_{\text{Market fundamental component}} + \underbrace{E_t\left[\frac{1}{(1+r)^{T-i}} P_T\right]}_{\text{Bubble component}} \quad (3)$$

where the price of the commodity at time *t* is dictated by the first term or by the market fundamentals (i.e. supply and demand). The price of commodity may deviate from the first term, as indicated by the right term or the bubble component. In the absence of a bubble then:

$$\lim_{k \to \infty} \frac{E_t[P_{t+k}]}{(1+r)^k} = 0. \quad (4)$$

Showing that the price of a commodity is solely reflective of the fundamental dynamics of the market when bubble does not exist, eq. 1 is equal to:

$$P_t^f = \sum_{j=1}^{\infty} \frac{1}{(1+r)^j} E_t[\varphi_{t+j}] \quad (5)$$

where Equation 5 is called price reflecting fundamentals. This simply means that the fundamental price contains all expected future payoffs. In order to obtain a unique solution, the bubble component, the discounted value of the commodity is normally assumed to converge to zero in the indefinite future. This is the transversality condition as in Equation 4 which rules out bubbles on the basis of a general equilibrium zero-sum argument (Tirole, 1982; Areal et al., 2014).

Without imposing transversality condition, the price of the commodity may be written as:

$$P_t = F_t + B_t, \quad (6)$$

where:

$$F_t = E_t\left[\sum_{i=1}^{T-i} \frac{1}{(1+r)^i} (\varphi_{t+i})\right]$$

$$B_t = E_t\left[\frac{1}{(1+r)} B_{t+1}\right]$$

The statistical properties of P_t are determined by F_t and B_t. That is, if φ_t is an I(1) process, F_t the discounted future stream of expected convenience yields is also an I(1) process. The relation, B_t is an empirical expression which embodies an explosive property and introduces 'bubble' movement in the price P_t over the fundamental component F_t.When bubble does not exist, $B_t = 0$, then the current price of the commodity is determined according to market fundamental, $P_t = F_t$ and if F_t is I(1), current prices are also I(1) (Areal et al., 2014).

Data and Sources

The study used monthly secondary data of the monthly futures prices of the selected commodities i.e. rubber, palm oil and rice. The description and period of observation of each of the commodity are presented in table 1.

Table 1. Summary of data, description and sources.

Commodity	Data	Source	Period covered	n
Rubber	Monthly Futures price of Singaporean smoked rubber sheets in US cent/ lb.	IMF	January 1980-December 2015	432
Palm Oil	Monthly Futures price of Malaysian Palm Oil US$/MT	IMF	January 1980-December 2015	432
Rice	Monthly Futures price of Thailand 100% grade B rice US$/MT.	IMF	January 1980-December 2015	432

The unit of price measurement is immaterial in the analysis since the price movement is what the study is looking into. The total number of observations for rubber, palm oil and rice prices is 432. The data were taken from the database of the Intentional Monetary Fund (IMF) and the World Bank (WB).

Bubble Identification Procedure

The use of the traditional unit root and cointegration-based tests proposed by Diba and Grossman (1998) may fail to detect the existence of bubbles when they are periodically collapsing. According to Evans (1991), when seeking to identify multiple periodically collapsing bubbles within a single data set using stationary tests, the process is greatly complicated and exposed to the possibility of identifying pseudo stationary behavior (Caspi et al., 2014). With these shortcomings, Homm and Breitung (2012) had compared several widely used techniques for identifying bubbles and found out that PWY (Phillip, Wu and Yu, 2011) strategy performs the best. PSY (Phillip, Shi and Yu, 2012), extended the methodologies of PWY (2011) and PY (Phillips and Yu, 2011) which employs a series of recursive bubble testing procedure. Using this date-stamping method the exact bubble origination and collapse dates can be determined and whether prices deviate from a random walk and become explosive (Etienne et al., 2013; PSY, 2013). These types of tests use a right tail variation of the Augmented Dickey-Fuller unit root test with the null hypothesis of a unit root and the alternative mildly explosive process (Caspi, 2013). In the left-tailed unit root testing, results are often sensitive to model formulation which in effect, the maintained hypothesis through the properties of the data are explored can influence outcomes in a major way (PSY, 2013).

For exposition, suppose that we use a sample interval [0, 1]. The ADF test estimates the sample window, $r_w = r_0 = 1$ is illustrated in Figure 1.

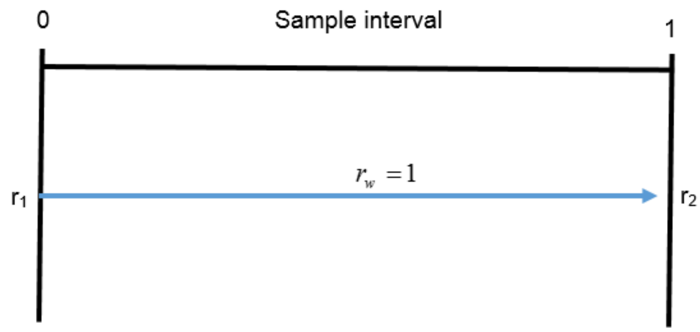

Figure 1. Illustration of the ADF procedure.
Source: Caspi, 2013.

Here, r_1 and r_2 are the first and the last observations of the sample respectively. Meanwhile, the supremum ADF (SADF) as proposed by PWY is based on the recursive calculations of the ADF statistics with a fixed starting point and forward expanding window (gradually expanding sample size) as shown in the Figure 2.

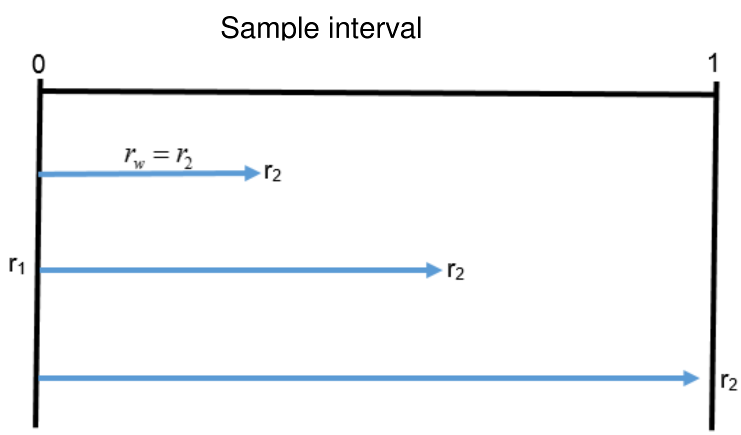

Figure 2. Illustration of the SADF procedure
Source: Caspi, 2013.

In SADF, the first observation in the series is fixed at the starting sample, $r_1 = 0$ while the window is gradually expanding with a varying end sample such that, $r_w = r_2$. The regression is recursively estimated while incrementing the window $(k+1)$ observation at a time wherein the end observation, r_2, depends on the predetermined fraction of the window size, r_0, such that $r_2 \in [r_0, 1]$, with the last regression utilizing the full sample *T*. The initial minimum fraction is selected arbitrarily while keeping in mind that the fraction must ensure estimation efficiency (Caspi et al., 2014). Each estimation yields an ADF statistic denoted as ADF r_2. Given that the last regression will utilize the whole sample, i.e., $r_2 = 1$ then the statistic is ADF_1. The supremum value of this ADF sequence (SADF) can then be used to test the null hypotheses of unit root against its right-tailed "explosive" alternative by comparing it to its corresponding critical values. Significant ADF statistics are indicated by $\beta_{r_1, r_2} > 1$, which can then be labeled as explosive (bubble) periods. The SADF statistic is defined as the *supremum* value of the ADF r_2 sequence for $r_2 \in [r_0, 1]$:

$$SADF(r_0) = \sup_{r_2 \in [r_0, 1]} \{ADF_{r_2}\} \tag{7}$$

Although the *sup* ADF detects periodically collapsing bubbles, date stamping its origin and subsequent collapse, it has its weakness when there are multiple bubble episode within the same sample period. This means that when the sample period includes multiple episodes of exuberance and collapse, the SADF test may suffer from reduced power and can be inconsistent, thereby failing to reveal the existence of bubbles (PSY, 2013). Hence, PSY developed a new econometric methodology called Generalized sup ADF (GSADF). While *sup* ADF uses a fixed initialization window (fixed startup data), GSADF uses a moving window with varying startup data. The illustration shown in Figure 3 shows the comparative sample sequence for GSADF.

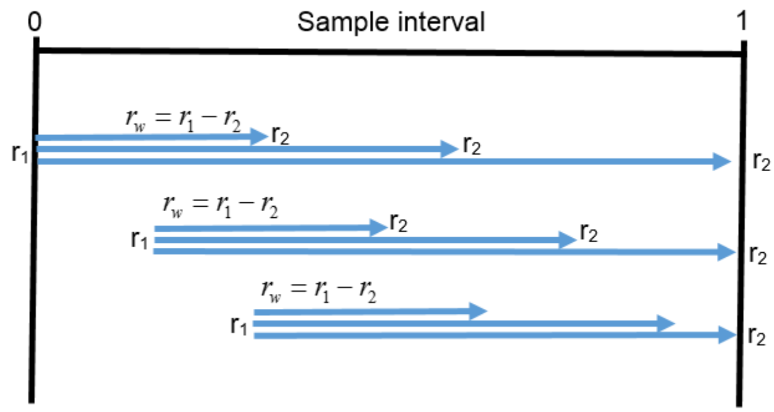

Figure 3. Illustration of the GSADF procedure
Source: Caspi, 2013.

The moving window avoids results being sensitive to sample start data and allow for the possibility of periodically collapsing bubbles (PSY, 2013; Balcombe and Rapsomanikis, 2013). Hence, the GSADF is constructed by repeatedly implementing the SADF test procedure. The GSADF statistic is defined as:

$$GSADF(r_0) = \sup_{r_2 \in [r_0,1], r_1 \in [0, r_2 - r_0]} \{ADF_{r_1}^{r_2}\}. \quad (8)$$

The method detects bubbles as they emerge not just after they burst (de Oliveira and Almeida, 2014). Using a supremum of a recursively estimated ADF statistic is the observation that price bubbles generally collapse periodically, with conventional unit root tests then having limited power in detecting such bubbles (Evan, 1991; Caspi et al., 2014; PSY, 2013). PY (2009) argued that the asymptotic distributions of the test statistics remain the same when a low lag order is used, hence PY (2011) used a lag order of zero when conducting the forward recursive analysis with initialization of the first observation(Etienne et al., 2013).

Empirical Model

The study used the methodology developed by PSY. The methodology is based on the repeated application of the Augmented Dickey-Fuller test using Equation 7 on subsamples of the data in recursive fashion (PSY, 2013). The reduced form of the empirical model can be written as:

$$\Delta P_t = \alpha_{r_1,r_2} + \delta_{r_1,r_2} P_{t-1} + \sum_{i=1}^{k} \phi_{r_1,r_2}^{i} \Delta P_{t-i} + \varepsilon_t \text{ , } t = 1,\ldots,T \qquad (7)$$

where: P_t =is the price of the commodity at time t;
α =is the intercept
δ =autoregressive coefficient
r_1, r_2 =the start and the end windows respectively
k =is the lag order
$\varepsilon_t \sim iid(0, \sigma_{r_1 r_2}^2)$

The parameters α , δ and ϕ are parameters estimated using OLS. Testing for bubble or explosive behavior is based on the right-tail variation of the standard Augmented Dickey-Fuller (ADF) unit root test with the null hypothesis of a unit root and the alternative of explosive autoregressive coefficient (Caspi, 2013). That is, $H_0 : \delta = 1$ tested against the right sided alternative $H_1 : \delta > 1$. The recursive estimation of Equation 7 will result in a sequence of ADF statistic calculated as ADF_{rk} for all values of $k \in (r_0, r_1)$. The supremum value of the sequence (SADF) is then used to test the null hypotheses of unit root against explosive alternative by comparing it to its corresponding critical values. Significant ADF statistics, indicated by $\delta_{r_1,r_2} > 1$, is defined to be explosive periods. The GSADF approach uses a variable window width allowing starting as well as end points to change within the feasible range $[r_0, 1]$, thereby allowing the identification of several bubble periods (Caspi et al., 2014). If the null hypothesis of no bubbles is rejected, the method of PSY enables to date stamp the origin and ending points of the bubble(s).

Bubble Date-Stamping Procedure

If the null hypothesis of no bubbles is rejected, the PSY procedure enables to consistently date-stamp the starting and ending points of the bubble(s). The starting point of a bubble is defined as the date, T_{re}, at which the backward sup ADF sequence crosses the corresponding critical value from below. Similarly, the ending point of a bubble is defined as the date, T_{rf}, at which the backward sup ADF sequence crosses the corresponding critical value from above. (Caspi et al., 2014).

Following Caspi et al., (2014), we can define the bubble periods based on the GSADF test by:

$$\hat{r}_e = \inf_{r_2 \in [r_0, 1]} \{ r_2 : BSADF_{r_2} > cv_{r_2}^{\beta_T} \} \tag{8}$$

$$\hat{r}_f = \inf_{r_2 \in [\hat{r}_e, 1]} \{ r_2 : BSADF_{r_2} > cv_{r_2}^{\beta_T} \} \tag{9}$$

where: $cv_{r_2}^{\beta_T}$ = $100(1-\beta_T)\%$ critical value of the ADF statistic based on $[T_{r_2}]$ observations.

Equation (8) and (9) marks the bubble start and bursting dates, respectively. The significance level of β_T depend on the sample size *T* and it is assumed that $\beta_T \to 0$ as $T \to \infty$. In empirical application β_T will often be fixed at some level such as 0.05 (PSY, 2013).

The Bubble

The study performed the recursive SADF and GSADF to test if the movement of palm oil, rubber and rice futures prices increase is supported by fundamentals or driven by speculation. The study chose the minimal window size of 0.05 or 5% as initial window size for all the commodities. A startup sample of 22 observations was set. The finite critical values were obtained via Monte Carlo simulations (MCS) with 1,000 iterations. The resulting SADF and GSADF t- statistics for the commodities are presented in Table 2. The null hypothesis of a random walk is rejected if either the GSADF or the SADF t-statistics is greater than the simulated critical values (at 90%, 95% and 99%), and conclude that a bubble exist.

As shown in Table 2, GSADF statistic indicates the existence of at least one bubble period with a 90% critical value for, rice, rubber and palm oil prices. The SADF found similar findings for all commodities except for palm oil.

Table 2. SADF and GSADF statistics for the selected commodities and their respective simulated critical values.

Commodity		t- Statistic	Critical Test Values			Probability (p-value right-tailed test)
			90% level	95% level	99% level	
Rubber	GSADF	6.1074	2.2996	2.6077	3.1155	0.0000
	SADF	5.5200	1.2787	1.4691	1.9685	0.0000
Rice	GSADF	22.2135	2.2996	2.6077	3.1153	0.0000
	SADF	4.0582	1.2787	1.4691	1.9685	0.0000
Palm Oil	GSADF	4.8341	2.2996	2.6077	3.1155	0.0000
	SADF	0.9932	1.2787	1.4691	1.9685	0.1990

Price Bubbles in Rubber

The bubble date-stamping procedure for rubber is presented in figure 4. In the figure, the green series is the actual rubber price, while the blue series represents the backward SADF sequence and the red line is the simulated 95% critical value. The starting date of a bubble may be visually inspected whenever the blue line crosses the red line from below which corresponds to the spike in the price of rubber above. Similarly, the end of the bubble is determined whenever the blue line crosses the red line from above. Statistically, the start of the bubble is marked by the first value of the GSADF which is greater than the GSADF cv value. In the same way, the end of the bubble is determined by the last value of the GSADF which is greater than the GSADF cv.

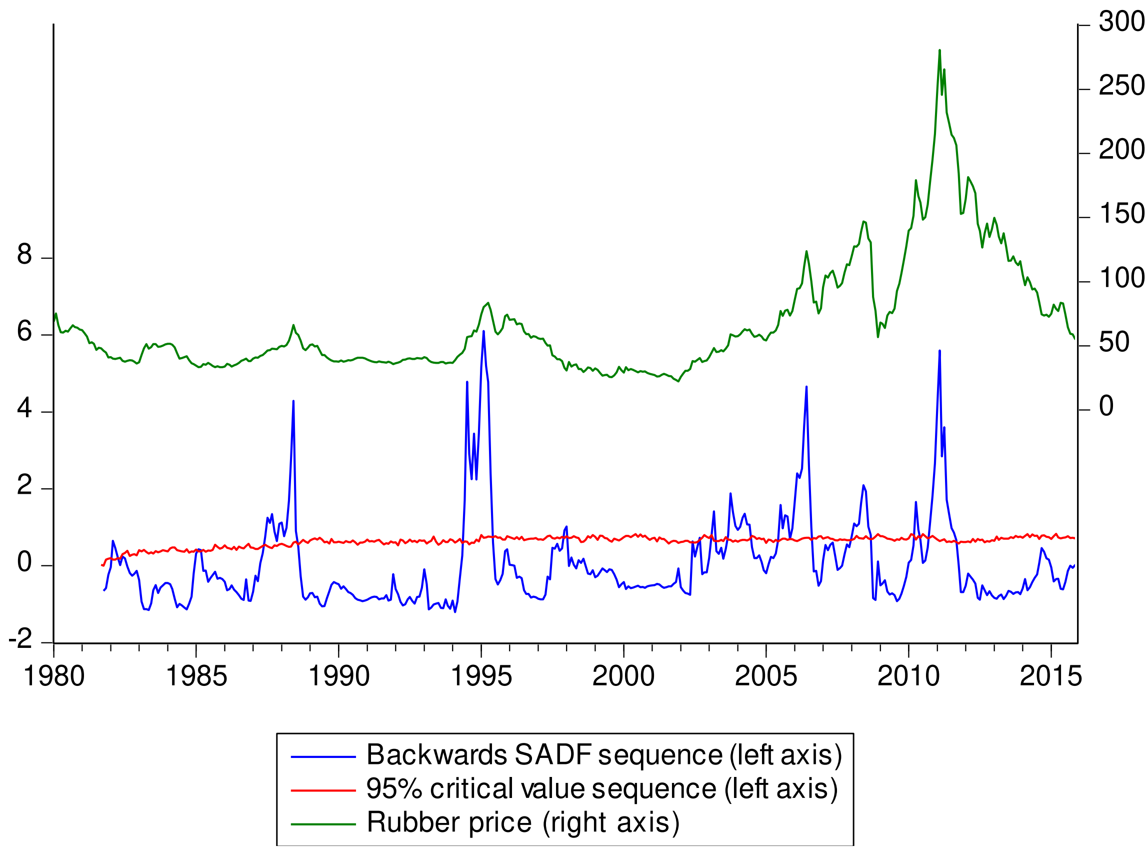

Figure 4. Backward recursive calculation of the SADF test for rubber price.

In figure 4, the BSADF detected six (6) evident multiple bubble clusters in rubber futures price during the years 1987-1988, 1994-1995, 2003-2004, 2005-2006, 2008 and 2010-2011. Table 3 summarizes the bubble periods for rubber price in their specific starting and bursting stages and the duration of each price exuberance. The average bubble duration for rubber is five (5) months with the January-September 2008 as the longest bubble period which lasted for nine (9) months. Most pronounced during this 9-month bubble is the price increase from April to May 2008 where there was a 7% climb in the price of rubber. Specifically, rubber price during the said period had increased from 129.51 to 139.05 US cent per pound.

Table 3. Summary of bubble periods for rubber price.

Starting Date	Termination Date	Duration (in months)
June 1987	November 1987	6
December 1987	February 1988	3
March 1988	July 1988	5
June 1994	August 1994	3
September 1994	November 1994	3
December 1994	May 1995	6
September 2003	January 2004	5
February 2004	June 2004	5
June 2005	February 2006	9
March 2006	August 2006	4
January 2008	September 2008	9
October 2010	March 2011	6
April 2011	September 2011	6

From the burst of September 2008, the price of rubber saw a 33% drop from 130.61 US cent per lb. in September to 88.05 US cents per lb. the following month.

From then, the price trend had been decreasing until another bubble had been formed on April 2010 which eventually collapsed a month after. One noticeable bubble behavior for rubber price is its multiple bubble periods with successive starting and termination dates.

Price Bubbles in Palm Oil

Figure 5 shows that for the palm oil price, two (2) evident bubble clusters had been observed during 1994-1995 and 2006-2008. The bubble duration for palm oil price is presented in table 5.

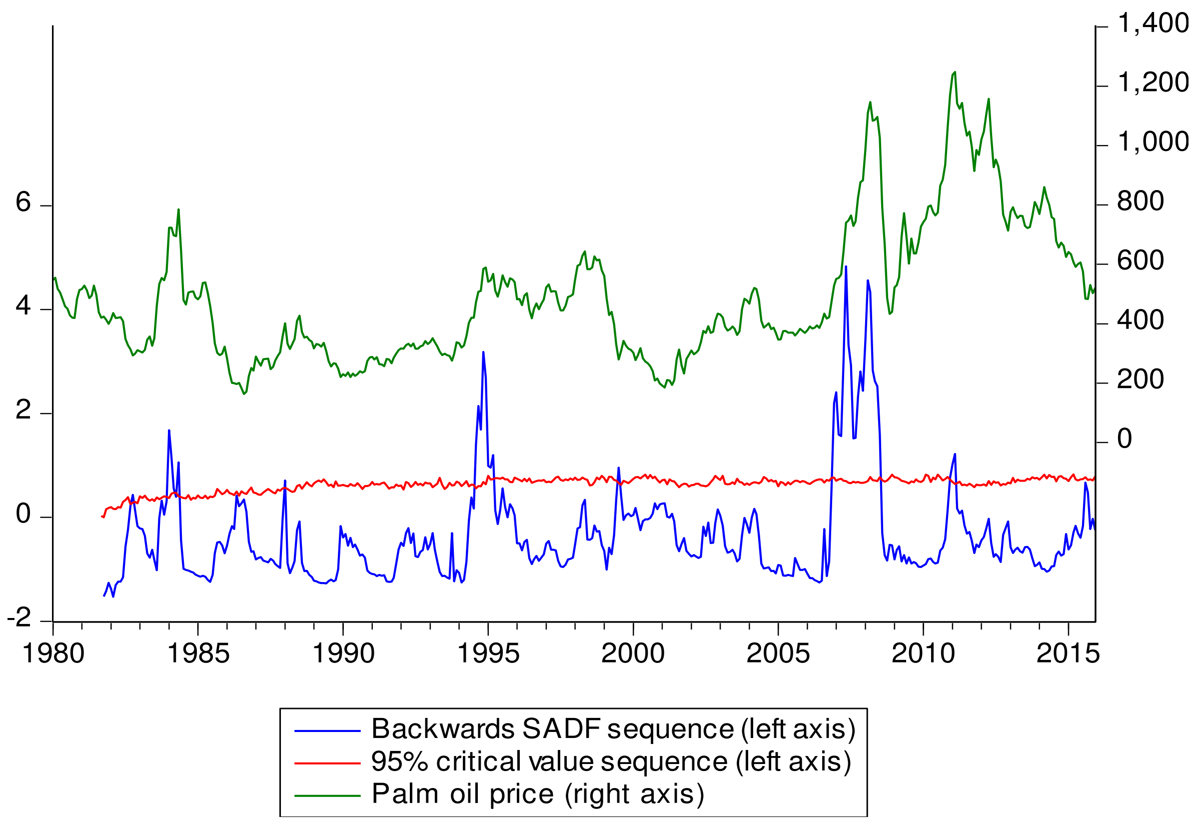

Figure 5. Backward recursive calculation of the SADF test for palm oil price.

The bubbles had an average duration of 4-month with a pronounced 8-month bubble in September 2007 to April 2008 where price exuberance extended up to eight (8) months. The September 2007- April 2008 price upswing is the third bubble from a series of four (4) multiple bubble periods which can be traced back since December 2006. From December 2006 up to the end of the bubble series on July 2008, or in two (2) years, the price of palm oil had dramatically swollen by 94%.

In 2007, individual agricultural exporting countries adopted some export restrictions to increase their domestic food supplies and restrain the increasing food prices. Malaysia along with the neighboring Indonesia, the leading exporters of palm oil, imposed export taxes on the product.

Table 4. Summary of bubble periods for palm oil price.

Starting Date	Termination Date	Duration (in month/s)
August 1994	September 1994	2
October 1994	February 1995	5
March 1995	March 1995	1
December 2006	March 2007	4
April 2007	August 2007	5
September 2007	April 2008	8
May 2008	July 2008	3

Price Bubbles in Rice

In general, the global price of rice had experienced several booms and bust cycles as shown in figure 6. During 2000-2001, the global rice nominal prices were at its lowest levels since the 1970s. This was mainly due to a huge buildup in global rice stocks in the second half of the 1990s, with China largely contributing to the buildup in global rice stocks. Beginning in 1999-2000, China implemented grain policies to reduce its excessive stocks. By early 2004, with global stocks at a more normal level relative to use, global rice prices began to slowly increase (Childs and Kiamu, 2009).

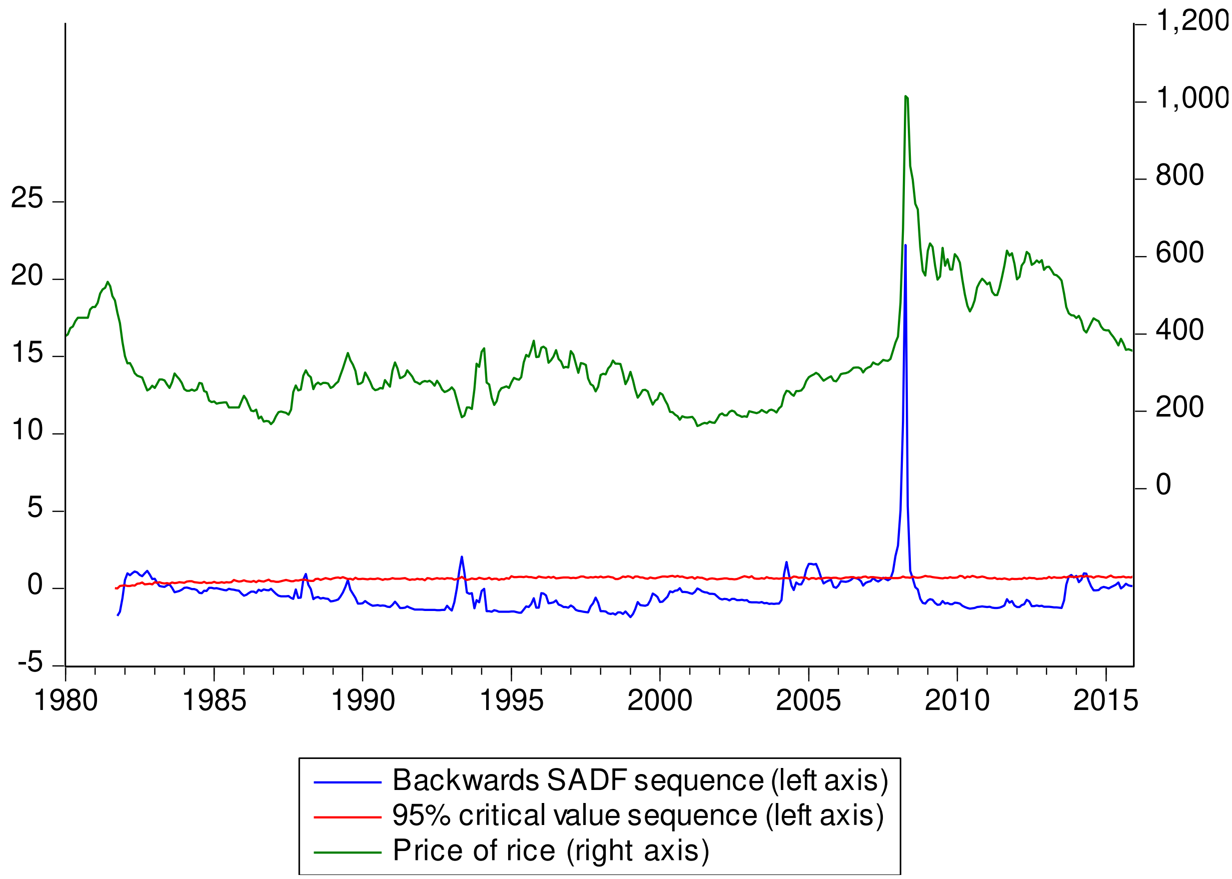

Figure 6. Backward recursive calculation of the SADF test for rice price.

The date-stamping procedure for rice shows that there was a 14-month bubble in January 1982 to February 1983 and was only succeeded a decade after by a three-month bubble in April-June 1993. Notable price exuberance was observed during the period November 2007- June 2008, where the GSADF statistic jumped to its peak in April 2008 with a value of 22.21. Correspondingly, the price of rice during the same period shot up to as much as 50% from its March 2008 value of USD675 per MT to USD1, 015 per MT in April 2008. The price slowly went down in May and the bubble finally burst in June 2008. Though the bubble ended on June 2008, where the price of rice is at USD799 per MT, the price continually decreased until it reached its bottom in December 2008 at USD624 per MT. Since 2012, the trend of the price of rice had been observed to decline.

In 2007, concerns over the sufficiency of domestic price stocks grew as countries noticed the dwindling world food supply and prices of key commodities such as rice were rising (Timmer, 2008). Both importing and exporting countries monitored red flags about changing scarcity. The Philippines for instance tried to build up stocks to protect it against shortages in the future. After the price acceleration in the gradual price increases which started in September 2007, rice exporting countries like India, Thailand and Vietnam adopted export controls. For example, India, the third largest producer of rice ion the world, substituted wheat over rice as a result of drought in 2007, and announced the procurement from domestic producers. Hence, an export restriction was imposed on rice exports in September 2007 and by February 2008. Thailand and Vietnam followed suit and adopted export restrictions.

Table 5. Summary of bubble periods for rice price.

Starting Date	Termination Date	Duration (in month/s)
January 1982	February 1983	14
April 1993	June 1993	3
November 2007	June 2008	8

Meanwhile, the ADB also pointed out that hoarding behavior is a contributory factor for the large spike in the price of rice. Financial speculation seems to have played only a small role partly because futures markets for rice are very thinly traded. Instead, decisions by millions of households, farmers, traders and some governments sparked a sudden surge in demand for rice and changed the gradual increase in rice prices from 2002 to 2007 into an explosion. This was "precautionary" demand even if not "speculative" demand as [opined by language Keynes (1936)] used in the debate over the role of speculative demand in the supply of storage (Timmer, 2009).

The bubble identification results found a similar finding with a number of literatures which have studied on the subject matter. The study found that there is a concentration of price exuberance within the period 2006-2008. The causes of such price spike are complex where combination of mutually reinforcing factors affects its behavior. Factors like low stocks for the commodities, competing use of commodities across industries, rapidly rising oil prices during the period and a continuing devaluation of the US dollar, the currency in which indicator prices for these commodities are typically quoted. Plus, there is no doubt that the turmoil in commodity markets had occurred against the backdrop of an unsettled global economy, which in turn appears to have contributed to a substantial increase in speculative interest in agricultural futures markets.

Summary and Conclusion

The rise in commodity prices had earned the attention of academicians, policy makers, and investors as the phenomenon had its effects on the economy, food security, and investment decisions. The study sought to determine the existence of a bubble or price exuberance and to eventually date-stamp the exact starting and termination dates of the price upswings. While the study did not attempt to determine why such price spike exists over a particular period, the study provided the dynamics of the international economy to place the bubble into perspective. Using the Generalized Supremum Augmented Dickey-Fuller, a right-tailed rolling version of the ADF, several bubbles had been discovered in all of the commodities under study. There is a particular concentration of bubbles during the periods 1982-1983, 1987-1988, 1994-1995, 2003-2004, 2006-2008 and 2010-2011 for at least three (3) of the commodities. These commodities play a critical importance for these commodities are the major agri-exports of the ASEAN countries i.e. Philippines, Indonesia, Malaysia, Thailand and Singapore.

The causes of price spike are complex where combination of mutually reinforcing factors affects its behavior. Factors like low stocks for the commodities, competing use of commodities across industries, rapidly rising oil prices and a continuing devaluation of the US dollar, the currency in which indicator prices for these commodities are typically quoted. Plus, there is no doubt that the turmoil in commodity markets had occurred against the backdrop of an unsettled global economy, political developments in major exporting and importing countries which in turn appears to have contributed to a substantial increase in speculative interest in agricultural commodities.

Recommendations

Based on the findings of the study, it is recommended that:

1. This study was able to isolate the periods where bubbles had emerged. Therefore, it would now be easy to determine the extent of the effects of other relevant variables through a univariate modeling framework.

2. In connection with the preceding item, upon isolating the periods of price exuberance, an investigation on the possibility of cross-commodity price transmission on the same periods may be conducted. This exploratory process is necessary to determine the connection of prices of the commodities. This is especially relevant for palm oil with coconut oil as its substitute, vice versa.
3. It is recommended that necessary measures must be adopted by countries where futures markets operate like in the US. One of these measures includes improving the transparency in commodity futures exchanges and over-the-counter markets. It is also further recommended that up to date data must be available for the use of the regulators.
4. A regulatory agency like the CTFC must be given additional powers to allow it to directly intervene in exchange trading. These powers include buying or selling derivatives contracts to avert possible price collapse or deflate bubbles.
5. Information on the current situation and outlook for global agriculture shapes expectations about future prices and allows markets to function more efficiently. Conversely, lack of accurate information on market fundamentals may reduce efficiency and accentuate price movements. Better information and analysis of global and local markets and improved transparency could reduce the incidence and magnitude of panic-driven price surges (FAO, 2011)
6. Countries must improve their capacity to produce consistent, accurate and timely agricultural market data and analysis, especially in response to weather shocks such as floods or droughts. Countries must increase their capacity to undertake more frequent and systematic monitoring of the state of crops and to develop

mechanisms for improved short-run production forecasts that are able to translate crop growth, meteorological and remote sensing data into yield and production expectations. Greater use could be made of satellite data and geographic information systems and, in this context, international coordination and exchange of technologies and information could be enhanced.

7. The creation and revival of an international supply management system for the agricultural commodities may cushion extreme price volatility. This system needs to secure a balanced growth between the supply of and demand for the commodities. This would help each country to safeguard their economies and alleviate the serious difficulties arising from surpluses or shortages of commodities.

List of References

Asian Development Bank (2011). Global food price inflation and developing Asia. ADB Report.

Alston, J.M., J.M. Beddow, and P.G. Pardey (2010), "Global Patterns of Crop Yields and Other Partial Productivity Measures and Prices." Retrieved from http://www.card.iastate.edu/books/shifting_patterns/pdfs/chapter3.pdf.

Areal, F.J., K. Balcombe, and G. Rapsomanikis (2014). Testing for bubbles in agricultural commodity markets. ESA Working Paper No. 14-07. Rome, FAO.

Balcombe, K. (2009). "The nature and determinants of volatility in agricultural prices: an empirical study from 1962-2008."

Bangko Sentral ng Pilipinas (2004). Bangko Sentral ng Pilipinas Annual Report Volume 1. Retrieved from http://www.bsp.gov.ph/downloads/ publications /2005/annrep2004.pdf

Yasunari, I. T. Kimata, T. Kimura, T. Muto (2011). Recent Surge in Global Commodity Prices. Bank of Japan Review. https://www.boj.or.jp/en/research/wps_rev/rev_2011/data/rev11e02.pdf

Cachia, F. (2014). Regional food price inflation transmission. Food and Agriculture Office Working Paper series.

Caspi, I. (2013). Rtadf: Testing for Bubbles with EViews. MPRA Paper No. 58791.

Caspi, I., N. Katzke and R. Gupta (2014). Date stamping historical oil price bubbles: 1876-2014. Stellenbosch Economic Working Papers.

Childs N. and J. Kiawu (2009). Factors Behind the Rise in RCS-09D-01 May 2009 Global Rice Prices in 2008. United States Department of Agriculture.

Clarete, R., L. Adriano and A. Esteban (2013). Rice Trade and Price Volatility: Implications on ASEAN and Global Food Security. ADB Economics Working Paper Series No. 368.

De Hoyos, R. and D. Medvedev (2009). Poverty effects of higher food prices: A global perspective. World Bank Policy Research Working Paper 4887.

De Oliveria, M. and C. Alexandre (2014). Testing for rational speculative bubbles in the Brazilian residential real-estate market. Retrieved from

Diba, B.T., and H.I. Grossman (1988). Explosive Rational Bubbles in Stock Prices? American Economic Review 78(3), 520-30.

Etienne, X., S. Irwin and P. Garcia (2013). Bubbles in food commodity markets: Four decades of evidence. Retrieved from: https://www.imf.org/external/np/seminars/eng/2012/commodity/pdf/irwin.pdf

Eugenio, S., H. Bobenrieth and D. Wright (2009). The food price crisis of 2007/2008: Evidence and implications. Retrieved from: https://are.berkeley.edu/~bwright/Wright/Publications_files/Panel_Discussion_paper_2_English_only-2.pdf

Evans, G.W. (1991). Pitfalls in Testing for Explosive Bubbles in Asset Prices. American Economic Review 81(4), 922-30.

Gerpacio, R., J. Labios, R. Labios and E. Diangkay (2004). Mazie in the Philippines: Production Systems, Constraints and Research Priorities. International Maize and Wheat Improvement Center.

Gilbert, C. and S. Pfuderer (2013). The financialization of food commodity markets. Retrieved from: http://www.zef.de/fileadmin/webfiles/downloads/News/News_4/Handbook_chapter_6.pdf

Gutierrez, L. (2011). Looking for Rational Bubble in Agricultural Commodity Markets. EAAE Congress, Switzerland.

Jiménez, Á. and J. Vilella (2011). Understanding economic bubbles. Retrieved from http://www.eco.uab.es/ue/trabajos%20premi/tfc%2061%20Jim%C3%A9nez%201.pdf.

Homm, U. and J. Breitung (2012). Testing for speculative bubbles in stock markets: a comparison of alternative methods. Journal of Financial Econometrics 10(1), 198-231.

Manzano, G. and Prado, S.A. (2014). Distributional impact of the 2008 rice crisis in the Philippines.

Kose O., X. Veillard and A. Harneja (2014). Extracting Value from Natural Rubber Trading Markets. Accenture Strategy.

Parcell, J. and V. Pierce (undated). Introduction to Hedging Agricultural Commodities with Futures. University Of Missouri-Columbia. Retrieved from http://www.le.ac.uk/users/dsgp1/COURSES/DERIVATE/RESOURCE/Agrihedge.pdf.

Phillips, P. C. B., S.P. Shi and J. Yu (2013). Testing for Multiple Bubbles: Historical Episodes of Exuberance and Collapse in the S&P 500. Cowles Foundation Discussion Papers.

Phillips, P.C.B., Y. Wu, and J. Yu (2011). Explosive Behavior in the 1990s Nasdaq: When did exuberance escalate asset values? International Economic Review 52(1), 201-226.

Phillips, P.C.B., and J. Yu (2011). Dating the timeline of financial bubbles during the subprime crisis. Quantitative Economics 2(3), 455-491.

Pindyck, R. S. (1993). The present value model of rational commodity pricing.

Stiglitz, J.E. (1990). "Symposium on bubbles," Journal of Economic Perspective 4(2):13-18.

Timmer, P. (2009). Dis speculation affect world rice prices? ESA Working paper no. 09-07. Food and Agriculture Organization. UN.

Tirole, J. (1982). On the Possibility of Speculation under Rational Expectations. Econometrica 50:1163-1182.

UNCTAD (2008). Addressing the global food crisis. Key trade, investment and commodity policies in ensuring sustainable food security and alleviating poverty. Retrieved from: http://unctad.org/en/Docs/osg20081_en.pdf.

_______ (2011). "Price Formation in Financialized Commodity Markets: The Role of Information." Study prepared by the secretariat of the United Nations Conference on Trade and Development.

Varadi, V.K.(2012). An evidence of speculation in Indian commodity markets. Munich Personal RePEc Archive. Retrieved from: https://mpra.ub.uni-muenchen.de/38337/1/

Valiante, D. (2013). Commodities Price Formation: Financialisation and Beyond, CEPSECMI Task Force Report, Centre for European Policy Studies, Brussels.

Verico, K. (2013). Economic Cooperation in Natural Rubber: The Impacts on Natural Rubber's World Supply and Indonesia's Economy. Asian Journal of Agriculture and Development. Vol. 10, No 2.

Wahl, P. (undated). Food Speculation. The Main Factor of the Price Bubble in 2008. Retrieved from: http://www2.weed-online.org/uploads/weed_food_speculation.pdf

Wright, B. (2014). Global biofuels: Key to the Puzzle of Grain Market Behavior. Journal of Economic Perspective 28(1), 73-98.