

Food Price Bubbles and Government Intervention: Is China Different? *

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Abstract: The last decade has witnessed different price trajectories in the international and Chinese agricultural commodity markets. This paper compares and contrasts these dynamic patterns between markets from the perspective of price bubbles. A newly developed right-tailed unit root testing procedure is applied to detect price bubbles in the CBOT and Chinese agricultural futures market during the period 2005-2014. Results show that Chinese markets experienced less prominent speculative bubbles than the international markets for its high self-sufficiency commodities (wheat and corn), but not for low self-sufficiency commodities (soybean). The difference in price behavior is attributed to differences in market intelligence, and to Chinese agricultural policies related to trade as well as domestic government policies. Besides, it discusses challenges to the sustainability of the stable price trajectory in Chinese markets.

Keyword: food; price bubble; government intervention; China

* The work was supported by National Natural Science Foundation of China and the China Scholarship Council. The authors also thank S.P. Shi, X.L. Etienne and L. Gutierrez for various support.

INTRODUCTION

Large swings in food prices occurred in the world market in last decade, which brought complex effects on farmers, consumers and market participants (Chavas et al., 2014). The last decade also witnessed different price trajectories in the international and Chinese food commodity market. International food prices approached dizzying heights in 2008 and 2010, followed by rapid collapses. Using January, 2005 as base prices (set equal to 100), the futures price indices for wheat, corn and soybean on the Chicago Board of Trade (CBOT) reached respectively 309, 265 and 194 in 2008, but fell back to 221, 170 and 128 in January 2009 (see Figure 1). In China, food prices followed different patterns. For wheat and corn, Chinese prices increased smoothly during the world price boom and bust. But Chinese prices for soybean also experienced large volatility (see Figure 1). This indicates different dynamic price patterns both across commodities and across countries. What is the nature of these differences? And what is their cause? This paper investigates these issues and attempts to answer these questions.

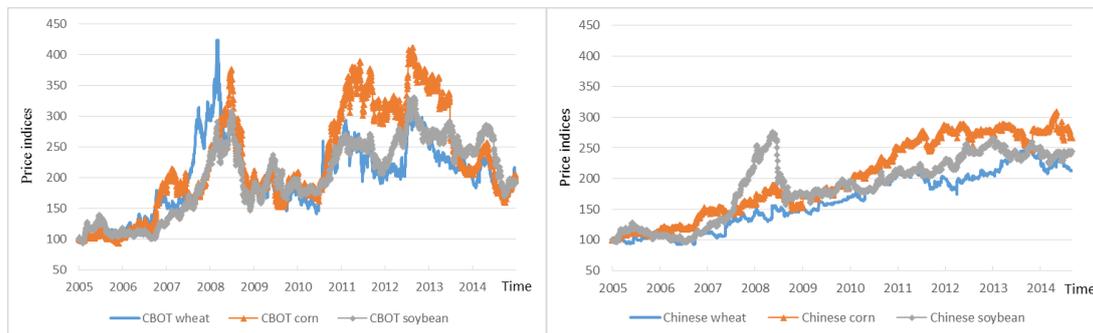


Figure 1. Daily CBOT and Chinese futures price indices: January, 2005 to December, 2014 (January, 2005 = 100)

As a country with a large population and rapid economic growth, China is now

playing a more important role in the world agricultural market. Being the largest consumer of a wide range of food commodities, China's rising food consumption demand has profound effects on the world food balance and trade pattern (Coxhead and Jayasuriya, 2010). The evolving food markets in China and in the world indicate a need to better understand how they function. An analysis of price trends and volatility can provide useful insights on the working and performance of markets. In turn, finding differences between world markets and Chinese markets raises questions about their causes. Identifying the reasons for the differences is of special interest to economists, market participants and policy makers. The supporting analysis provides useful insights on the quality of market intelligence. In addition, the effects of domestic policy and of trade policy on food price volatility are of particular significance.

As far as we know, this is the first paper to research differences between markets from the perspective of explosive processes and price bubbles. The paper has two main objectives. The first objective is to compare and contrast price dynamics in international and Chinese agricultural markets over the last decade. The analysis examines three key agricultural markets: wheat, corn and soybean. It investigates whether there are more "price bubbles" in international markets than in Chinese markets. The second objective is to try to explain the observed differences, with a special focus on the role of government policies and the quality of market intelligence.

The economics of price bubbles has been examined in previous literature. Price bubbles are typically associated with boom-bust situations where explosive price patterns are followed by rapid price declines. The explosive aspects of a price bubble

make it different from more conventional price dynamics.¹ Associating the rapid price increases with unstable dynamics, price bubbles arise in unstable markets. As discussed in rational price bubble literature (Blanchard 1979, Blanchard and Watson 1982), continuous unusual price movements can be used to evaluate whether markets are driven by a bubble component. Most bubbles are short-lived, indicating that they reflect short-term dynamics that differ from the longer-term market fundamentals. If they involve departures from long-term supply/demand conditions, bubbles reflect in part the quality of information available to market participants. In this case, bubbles are more likely to arise when “market intelligence” is poor. This could happen when market participants are not well informed about market conditions. For example, if some private traders and/or policy makers (e.g., government agencies involved in pricing and trade policy) “overreact” to information about scarcity, they may contribute to short-term explosive price patterns. Bubbles being short-lived are an indication that such behavior is likely to be specific to particular periods, markets and situations.

Empirically, the investigation of bubbles involves a search for unstable price dynamics. Dynamics is said to become unstable if it enters an explosive process. The presence of a “unit-root” defines the boundary between stable and unstable dynamics. Thus, price bubbles can be identified by evaluating whether the process underlying market dynamics crosses the “unit-root” boundary as prices become unstable. Recently, great progress has been made in the econometric analysis of bubbles and explosive

¹ For example, the analysis of conventional price dynamics has included the use of cointegration methods (e.g., Hua and Chen, 2007; Liu and An, 2011). Such methods do not consider the explosive process associated with bubbles.

processes (Phillips and Magdalinos, 2007, Phillips, et al. 2010). Building on the Augmented-Dickey-Fuller (ADF) test for a unit root, Philips et al. (2011) and Philips et al. (2012) developed an effective testing procedure for speculative bubbles, including their timing and duration (Phillips, Wu et al. 2011, Phillips, Shi et al. 2012). These tests have been used to investigate price bubbles in agricultural commodity markets, with special focus on the 2008 and 2010 price spikes (Gilbert, 2010b; Gutierrez, 2013; Etienne et al. 2014a, 2014b). However, previous studies have focused on the detection and date-stamping of bubbles based on the data from international markets. The question remains of whether Chinese markets exhibit different price behavior.

As noted above, this paper studies the differences in price dynamics and bubbles between the international and Chinese markets for wheat, corn and soybean. Compared to international markets, the analysis finds that bubbles are less prominent on Chinese markets for wheat and corn, but more prominent for soybean. The differences involve both the number of bubbles and their duration. The paper also discusses the reasons for these differences. Of special interest are the pricing patterns during the large price spike of 2008. Numerous factors have been proposed to explain the recent world food crises. They mainly include natural disaster, energy price transmission, index investment speculation and government intervention (McCalla 2009; Gilbert, 2010a; Irwin and Sanders, 2011, 2012a, 2012b). The first two factors seem not to be the reason for the different price trends due to the fact that China is also considered to be a high agriculture-risk country and to have high energy price and fast-increasing energy demand. Irwin and Sanders (2011, 2012a, 2012b) argued that index trading itself is

likely not responsible for recent price movements on international food markets. But why are price dynamics different on Chinese agricultural markets?

We argue that government interventions help explain why there are fewer bubbles on the Chinese wheat and corn markets. This involves both Chinese domestic policy and trade policy. Indeed, the Chinese government has attached some importance to domestic food security issues. Over the last decade, China has changed from taxing to subsidizing its agricultural sector (Anderson et al., 2013). It has also implemented a series of price stabilization policies (Yang, et al., 2008; Liu et al. 2013). Together with trade restrictions, such policies have insulated the Chinese markets for wheat and corn, thus reducing the effects of international price spikes. In turn, this stabilized domestic prices and reduced the incidence of price bubbles in the Chinese wheat and corn markets. But Chinese government policy has been less active for soybean. The finding that bubbles are more common in the Chinese soybean market provides indirect evidence of relatively low market intelligence in that market. Implications of these findings are discussed, along with an evaluation of the prospects and challenges for markets and agricultural policy in China.

The paper is organized as follows. We describe the testing procedure for price bubbles in the second section. The third section describes our data, and the fourth section presents the empirical results. In the fifth section, we evaluate the price trajectory in Chinese agricultural markets along with the role of government intervention. The sixth section discusses challenges to the sustainability of Chinese price stabilization policies. Concluding remarks are presented in the seventh section.

METHODOLOGY

Asset price bubble detection is a challenging issue. According to the review by Gürkaynak (2008), there are 4 main methods for detecting price bubbles, namely variance bounds tests (Shiller 1980, LeRoy and Porter 1981), West's two-step tests (West 1987, Chirinko and Schaller 1996), integration/cointegration based tests (Diba and Grossman 1987) and the intrinsic bubble test (Froot and Obstfeld 1992). However, none of these methods is demonstrated to effectively detect bubbles that collapse periodically, which is also called the 'Evens trap' (Evans 1991, Gürkaynak 2008). In fact, the failure of these methods is due to the low discriminatory power in distinguishing an explosive process from a unit root process. Bubble detection can be reduced to testing for a change from unit root to explosiveness. In recent years, important breakthroughs have been made in moderate deviation unit root theory, in which the underlying distributional issues are solved by applying the notion of mild explosivity (Phillips and Magdalinos, 2007; Magdalinos and Phillips, 2009; Phillips et al., 2010).

Phillips, Wu and Yu (2011, PWY herein after) proposed a new strategy to detect and date-stamp financial price bubbles. Building on the simple Augmented Dickey-Fuller (ADF) test, their procedure shows significant discriminatory power in bubble detection with two special designs: the right-tailed unit root and a forward recursive regression. The supremum function is employed to calculate the sup ADF (SADF) test statistic. Comparing SADF with the right-tailed critical values calculated from $\sup_{r \in [r_0, 1]} \int_0^r \tilde{W} dW / (\int_0^r \tilde{W}^2)^{1/2}$ provides tests for the unit root process against

explosiveness, and comparing the recursive ADF statistic against the corresponding right-tailed critical values of the standard ADF statistic allows date stamping of the origination and collapse of bubble periods. However, the PWY procedure is demonstrated to be not powerful in the scenario of periodically collapsing multiple bubbles, which seem to happen regularly in real markets.

Therefore, Philips, Shi and Yu (2012, PSY herein after) revised the SADF statistic and proposed a Generalized SADF (GSADF) test by iterative implementation of the SADF test. The PSY procedure improves the performance of the PWY procedure and effectively increases its discriminatory power. The analysis begins with the bubble definition in rational bubble theory, where the futures price could be written as $F_t^f + B_t$, where F_t^f is the fundamental component and B_t is the bubble component. In the rational bubble framework, the bubble component B_t manifests explosive dynamics. Thus, under the null hypothesis, the futures price F_t^f follows a random walk with a negligible drift:

$$F_t = dT^{-\eta} + \theta F_{t-1} + \varepsilon_t, \theta = 1 \quad (1)$$

where d is a constant, T is the sample size, $\eta > 1/2$ and ε_t is an *i.i.d.* error term. As recommended in Shi, et al. (2010), there is an intercept but no time trend in the regression model. Under the alternative hypothesis, there are bubbles in the time series.

Denote r_1^{th} and r_2^{th} as the starting and ending fraction of the sample, and r_w as the window size. Then we have $r_2 = r_1 + r_w$. Thus, the regression model is:

$$\Delta F_t = \alpha_{r_1, r_2} + \beta_{r_1, r_2} F_{t-1} + \sum_{i=1}^k \gamma_{r_1, r_2}^i \Delta F_{t-1} + \varepsilon_t, \varepsilon_t \sim i.i.d. N(0, \sigma_{r_1, r_2}^2) \quad (2)$$

where $\Delta F_t = F_t - F_{t-1}$ and k is the number of lags. Then, the corresponding standard Augmented Dickey-Fuller (ADF) statistic is

$$ADF_{r_1, r_2} = \beta_{r_1, r_2} / se(\beta_{r_1, r_2}) \quad (3)$$

Different from the standard ADF test, the PSY method is based on the recursive implementation of right tailed unit root tests (Formula 3) on the sample sequences. In practice, the PSY bubble detection procedure can be divided into 2 steps: 1/ to detect the existence of price bubbles using the GSADF statistic; and 2/ if bubbles hold, to date-stamp the origination and determination of the bubble period using the backward SADF (BSADF) statistic.

In the first step, the GSADF statistic is calculated both varying the end point of the regression r_2 from r_0 to 1 and varying the starting point r_1 from 0 to $r_2 - r_0$. Thus, the GSADF statistic becomes the largest ADF statistic over the feasible range from r_1 to r_2 . It is denoted as:

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

Therefore, the overall judgment whether bubbles exist can be drawn by comparing the sample GSADF statistic with the asymptotic critical values calculated by the Monte Carlo simulation of the same sample size.

In the second step, obtain the BSADF statistic sequence from implementing the right-tailed ADF test on backward expanding sample sequences, and then compare the BSADF statistic sequence with critical values of the SADF statistic calculated from Monte Carlo simulation. Now let $r_w = r_2 - r_1 + 1$, and r_{w_0} be the minimum window size of the estimated model. Then move the starting point r_1 between the first

observation to the observation $r_2 - r_{w_0} + 1$. Denoting $BSADF_{r_2}$ as the supremum of all $r_2 - r_{w_0} + 1$ ADF statistics with the fixed ending point at r_2 we have:

$$BSADF_{r_2} = \sup_{r_1 \in [1, r_2 - r_{w_0} + 1]} ADF_{r_1, r_2} \quad (5)$$

Then, allowing the ending point to vary from r_{w_0} to the last observation of the sample, we obtain the BSADF statistic sequence. The criteria for date origination and determination are:

$$\widetilde{r}_{1e} = \inf_{r_2 \in [r_{w_0}, T]} \{r_2 : BSADF_{r_2} > cv_{r_2}^\beta\} \quad (6)$$

$$\widetilde{r}_{1f} = \inf_{r_2 \in [\widetilde{r}_{1e} + h, T]} \{r_2 : BSADF_{r_2} < cv_{r_2}^\beta\} \quad (7)$$

where $cv_{r_2}^\beta$ represents the $\beta\%$ critical value of the backward-expanding SADF statistic based on the r_2 observations from Monte Carlo simulation. To be noted, we need to denote $h = \delta \log(T)$ is the minimum length of the bubble period, where δ depends on data frequency.

DATA

Futures price at time t for delivery of a commodity at time T is the expected value conditional on the information available at time t (Fama and French, 1987; Etienne, et al., 2014a). Many studies showed that the agricultural futures price changes lead to spot price changes in both the international and the Chinese market (e.g., Liu and Wang, 2006; Hernandez and Torero, 2010). Moreover, futures price data are available at a higher frequency. Compared with monthly and weekly data, daily price data are more informative to show the real origination and determination of bubbles. In current futures markets, prices change quickly because market information is highly

transparent and participants react rapidly to new information (Etienne et al., 2014). Hence, we choose daily futures prices series to evaluate price behavior and investigate the existence and nature of bubbles.

International and Chinese food commodity contracts are collected from the Chicago Board of Trade (CBOT), Dalian Commodity Exchange (DCE) and Zhengzhou Commodity Exchange (ZCE), the latter two being large commodity trading exchanges in China. Futures contracts include 3 food commodities, namely wheat, corn and soybeans². Our empirical analysis uses the daily settlement price of each commodity trade in CBOT, DCE and ZCE from January, 2005 to December, 2014. Thus, there are 2509 observations for the commodities in CBOT, and 2425 observations for the commodities in Chinese futures exchanges. We choose January 2005 as the starting point so that our sample covers the main recent booms and subsequent busts³.

Continuous futures price series need to be created and aligned in an appropriate way. In this study, we create the continuous price sequences by an adjusted front-month method⁴, which rolls nearby contracts at the end of the month prior to contract expiration. By doing this, we try to avoid “delivery period problems” caused by relatively low trading volumes and open interests in the maturity month in futures

²The specified futures contracts are Wheat Futures(W), Corn Futures(C), Soybean Futures(S) in CBOT, No.1 Soybeans Futures(A), Corn Futures(C) in DCE, Wheat Futures(WH) in ZCE. Although rice is an important agricultural product in China, it was not traded in Chinese futures markets before April, 2009. As a result, the data on Chinese rice prices do not cover the most volatile period in 2008. Thus, rice is not included in this research.

³In our data, the minimum window size for PSY procedure is about 115 observations. Thus, the real testing period is from June, 2005 to December, 2014, which contains the well-known price spikes in 2008, 2010 and 2012.

⁴Taking September Corn futures as an example, our rolling method uses November contract prices in conducting continuous data with the days in delivery month from September 1 to September 15.

markets (Karali and Power 2013). We then calculate Chinese futures price (Yuan per ton) into CBOT price (US dollar per bushel) using the daily China-U.S. Foreign Exchange Rate⁵, and obtain the corresponding price indices by normalizing prices for each commodity to 100 on the first trading day. Note that we use nominal prices instead of real prices as commonly done in studies using daily prices and cross-country samples (e.g., Esposti and Listorti, 2013; Gutierrez, 2013; Etienne et al., 2014a, 2014b). The exchange rates used for transforming prices to a common currency should reflect all differences in the rate of inflation between countries.⁶

Table 1 presents some summary information about the price sequences. As illustrated, the average prices in the Chinese markets are higher than those in the CBOT markets. Minimum prices in both the CBOT and the Chinese futures markets occurred in 2005-2006. However, maximum prices in the CBOT markets peaked in 2008 and 2012 price spikes, while price peaks in the Chinese markets showed up in the later parts of the sample period, except for soybeans. These results are consistent with our previous evaluation about price differences in international and Chinese agricultural markets.

Table 1. Data description of CBOT and Chinese commodity prices: 2005-2014 (US dollar per bushel)

Market	Commodity	Period	Observation	Mean	Max.	Date(max)	Min.	Date(min)
CBOT	Wheat	1 Jan, 2005–31 Dec, 2014	2509	599.5	1280.0	27 Feb, 2008	287.7	4 Feb, 2005
	Corn	1 Jan, 2005–31 Dec, 2014	2509	453.9	831.3	21 Aug, 2012	186.3	29 May, 2005
	Soybean	1 Jan, 2005–31 Dec, 2014	2509	1081.1	1771	4 Sep, 2012	499.5	4 Feb, 2005
China	Wheat	1 Jan, 2005–31 Dec, 2014	2426	866.1	1297.1	26 Dec, 2013	485.1	30 Jun, 2006
	Corn	1 Jan, 2005–31 Dec, 2014	2426	707.3	1080.9	29 Aug, 2014	348.3	5 Jan, 2005
	Soybean	1 Jan, 2005–31 Dec, 2014	2426	1573.8	2311.3	2 Jul, 2008	808.0	14 Aug, 2006

⁵Daily China-U.S. Foreign Exchange Rate data are collected from Board of Governors of the Federal Reserve System (US).

⁶ Practically, daily deflator data such as CPI or GDP deflators are not available (see Esposti and Listorti (2013) for a review).

EMPERICAL RESULTS

Figure 2 graphs the trajectories of the BSADF statistics and corresponding critical values, which are calculated from Gauss X6 software. From the results, strong evidence is found for speculative bubbles in all commodities in CBOT, namely wheat, corn and soybean, while in Chinese commodities we just find strong evidence in the soybean price sequence.

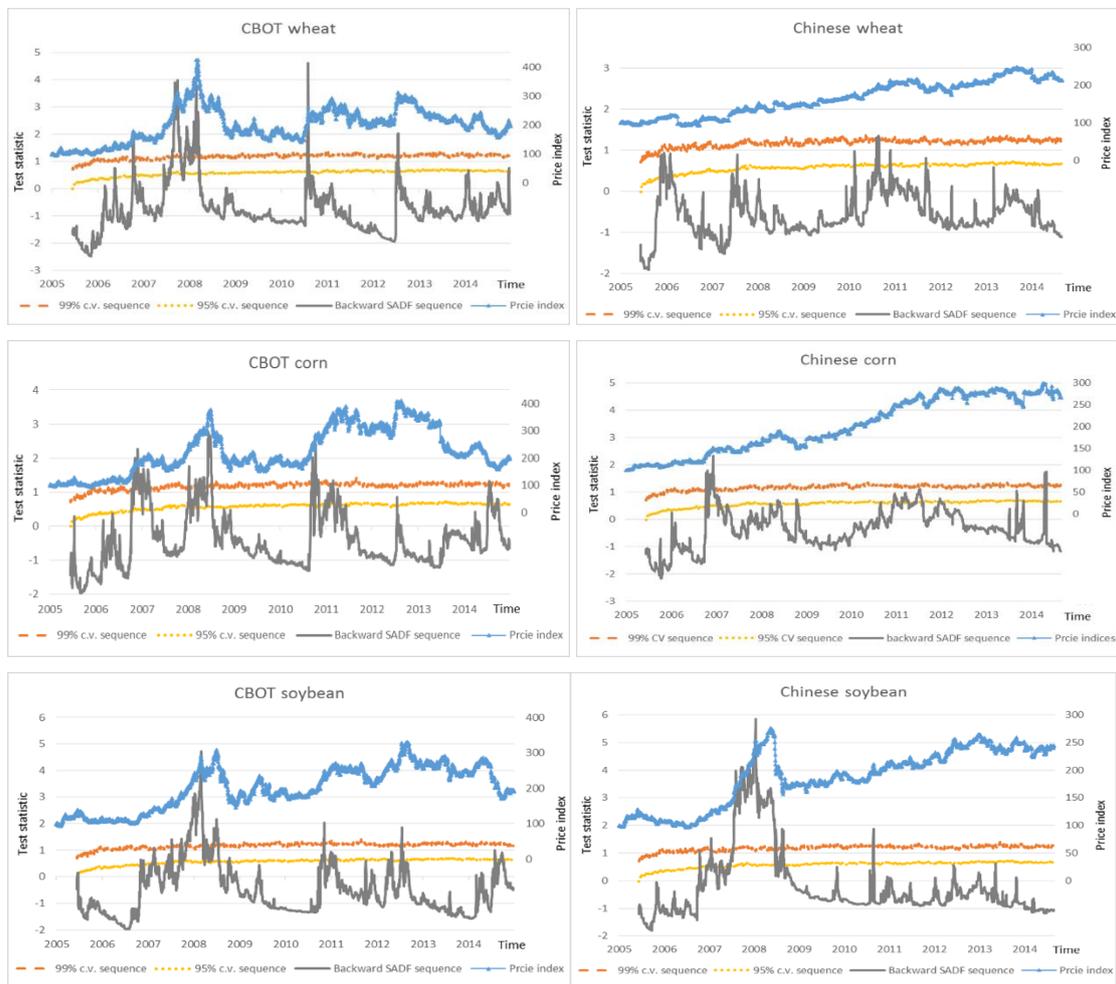


Figure 2. Explosive episodes in wheat, corn and soybean prices in CBOT and Chinese futures markets: 2005-2014

Note: 95% and 99% CV sequences and backward SADF sequence are labeled using left axis, and price indices are labeled using right axis.

As discussed in Section 2, empirical results are obtained by 2 steps. In the first step, we compare the sample GSADF statistic with the 95% and 99% critical value sequences obtained from the 5000 Monte Carlo simulations. Results show that the GSADF statistics are 4.60, 2.74 and 4.72, respectively, for wheat, corn and soybeans in the CBOT markets, and 1.35, 2.34 and 5.86, respectively, in the Chinese futures markets. With the exception of the Chinese wheat price, the sample GSADF statistics are greater than the 95% and 99% critical values of 0.73 and 1.41 for both the CBOT and the Chinese commodities. This indicates strong evidence of explosiveness in the prices of agricultural commodities. In the second step, to date-stamp the bubble occurrence, we compare the backward SADF sequence calculated from each commodity price sequence with the critical value obtained from the 5000 Monte Carlo simulations with the same observations. In this research, 95% and 99% critical value of asymptotic backward SADF sequences are applied to date-stamp the explosive periods. Following PSY (2011), the bubble length is evaluated as $\delta \log(T)$. In our daily data, δ is set to be 1.47 allowing the bubble period to be at least 3 days⁷. Detected bubble days against 95% and 99% critical value sequences of each commodity are reported in Table 2.

Table 2. Detected bubble days in CBOT and Chinese commodity markets

cv	market	Wheat	corn	soybean
99%	CBOT markets	122	126	131
	Chinese markets	0	29	239
95%	CBOT markets	182	343	285
	Chinese markets	27	196	328

⁷ Follow the study of Etienne (2014a), the minimum bubble period is set to be 3 days, because price bubbles are likely to be short-lived in modern highly competitive markets.

Almost all detected bubble periods happened in price spikes, referred to as “positive bubbles”. Moreover, each well-known price spike triggers an obvious escalation in BSADF sequences, which implies that the PSY procedure is suitable to analyze multiple bubble scenarios in agricultural commodity markets. The correspondence between detected bubbles and well-known unusual price movements not only rules out the possibility of “pseudo bubbles” caused by “splicing bias”⁸, but also verifies explosivity existing in the periods of unusual price behavior. Even though these results do not allow us to directly attribute the explosive processes to a specific speculative factor (such as hoarding or other financial trading), they do provide useful insights into the existence of price changes that deviate from market fundamentals (Gutierrez, 2013). Further, from the perspective of price bubbles, price trend can be compared by both length and magnitude. In this study, we further analyze bubble behavior in both markets from 4 aspects, namely the detected bubble days, bubble periods, the longest bubble duration and deviation rate during the bubble period.

Given 99% critical value of asymptotic backward SADF, there are 126 and 122 detected bubble days for corn and wheat in the CBOT market, while those numbers are only 35 and 0 for the corresponding commodities in the Chinese futures market. Similar results could be obtained using 95% critical values (see Table 2). However, it is interesting to see that there are more detected bubbles in the Chinese soybean futures markets than in the CBOT market using 99% critical values, and the bubble days are

⁸“Splicing bias” is a problem that needs special attention in futures price research. It refers to the potential overlapping switch price from one nearby contract to the next one, and causes price variation unrelated to true volatility or “pseudo bubbles” at the splicing date.

getting closer using 95% critical value. We will further discuss this different price behavior in the Chinese soybean market in the fifth section. In addition, nearly all the detected explosive processes belong to positive bubbles, which occur during price spikes. Overall detected bubble days give us information on how many days commodity prices in both markets deviated from intrinsic values based on market fundamentals.

According to the third column of Table 3, more bubble periods are detected for all 3 commodities in the CBOT market than in the Chinese market. Moreover, bubble periods exist in the very well-known commodity price spikes of 2008, 2010 and 2012 in the CBOT markets, while bubble periods are limited mostly to the 2007-2008 world food crisis in the Chinese markets. As further discussed below, this likely reflects the fact that the Chinese government increased agricultural support prices after the 2008 food crisis, which likely contributed to the stabilization of Chinese markets for corn and wheat. To be noted, soybean prices in the Chinese market shared all the bubble periods at roughly the same time as the CBOT market.

Table 3. Price bubble comparison between CBOT and Chinese futures markets

Commodity	Market	Bubble days	Bubble periods	Maximum single bubble duration	Deviation rate during largest bubble period
Wheat	CBOT	122	9	44	133%
	China	0	0	0	0
Corn	CBOT	126	16	26	118%
	China	29	5	8	103%
Soybean	CBOT	131	5	87	149%
	China	239	3	228	186%

Note: this table are calculated using the 99% critical value sequence and the minimum bubble period of 3 days.

Bubble duration gives us insights into the time that the price deviates from the fundamental value in the market. The longest bubble duration for wheat, corn and soybean prices in the CBOT market are 44, 26 and 87 days, respectively, while those in the Chinese futures market are 0, 8 and 228 days, respectively. Generally speaking, higher speculation happened in the world market with more bubble periods and longer durations than in the Chinese markets for corn and wheat. However, the 228-day bubble from 2007 to 2008 in the Chinese soybean futures market indicates significant instability of that market.

Price behavior can also be evaluated by the deviation rate during the price bubbles using the peak-trough ratio. Column 6 in Table 3 reports deviation ratios in the largest detected bubbles in each commodity in both markets. The deviation ratios of wheat and corn in the CBOT market are 133% and 118%, both higher than those in the Chinese market. Compared with wheat and corn, bubbles in the soybean market are relatively larger in magnitude. The maximum prices in the CBOT and the Chinese soybean market are 49% and 86% higher than the minimum prices during their largest bubble periods.

Thus, from the perspective of price bubbles, we find strong evidence of exuberance for all three food commodities in the international market⁹. We find less evidence of price instability in the Chinese market for corn and wheat, but more evidence of instability in the Chinese market for soybean. Using the rational bubble

⁹The results are consistent with those reported in Gutierrez (2013) with critical values obtained from wild bootstrap method except that they give minor evidence for price bubbles in CBOT soybean market. The proportion of bubble days, occupying about 5%, are relatively small in absolute value, which is also roughly consistent with the detected result of 2% in 5 grain futures markets in Etienne (2014b).

model, the results show that, compared with the Chinese market, the international markets for wheat and corn are more speculative, as the price sequences experienced heavier price explosiveness and longer periods away from market fundamentals. However, for soybeans, the Chinese market is found to be more unstable than the international market and shares almost every bubble period with the CBOT market. We will further discuss the difference within the Chinese commodities in the fifth section.

Finally, to verify the validity of these results, we performed some robustness checks in our dataset. We repeated the analysis by changing the starting point of the sample and by dividing the sample into two subsamples. In all cases, the conclusions remained the same. Thus, the empirical results are robust for bubble detection and date-stamping.

EXPLANATIONS

In this section, we discuss and interpret our findings with the objective of finding explanations for the different price trajectories. In this context, we attempt to explain how China managed to avoid bubble periods in the grain markets (wheat and corn), but not for the soybean market. As discussed in Section 1, many factors can potentially contribute to price volatility. Finding differences between international markets and Chinese markets is instructive. For each commodity, these differences must be attributed to market conditions that are specific to China. Hence, we evaluate what are the key factors that make agricultural price dynamics different in China.

As discussed in Section 1, we start with the role of Chinese government policies. China is one of the few countries which officially lists food security as a top priority in

government goals¹⁰. As a result of having experienced continuous famines for decades before the celebrated reform in 1978, the Chinese government attaches great importance to domestic food market. Starting in 2003, it has set comprehensive subsidizing instruments to help improve domestic food security. Unfortunately, a lack of good data on Chinese agricultural policy (e.g., no public data exist on government stocks) makes it difficult to investigate these issues quantitatively. Following the convention of previous studies (i.e., Gouel, 2014), we proceed with a qualitative analysis of the linkages between price dynamics and Chinese agricultural policy. We focus on narratives of the effect of Chinese government intervention on stabilizing domestic price, using both domestic policy and trade policy.

The main difference between Chinese grain and soybean is self-sufficiency rate. Chinese grain has the high self-sufficiency rate of over 95%, while soybean is the largest import commodity with the self-sufficiency rate of less than 25%. Thus, we divide our discussion of the effects of Chinese government intervention on price bubbles into two groups, namely high self-sufficiency commodities (wheat and corn) and low self-sufficiency commodities (soybean).

The Role of Domestic Policy

In the early 2000's, Chinese policy switched from taxing its agriculture to subsidizing (Anderson et al., 2013). Among the policy changes, two key programs are influential in price stabilization: the Minimum Purchase Price (MPP) policy, and the

¹⁰ See in Chinese official documents, i.e., China's No. 1 Central Document for 2014, available at: http://english.agri.gov.cn/news/dqnf/201502/t20150203_24952.htm

National Provisional Reserve (NPR) policy¹¹. These two policies were put in place in an attempt to improve Chinese food security. Note that such policies are similar to the support price policies used by the US and the EU in the middle of twentieth century (see Gardner (2006) for the US, and Grant (1997) for the EU). Over the last 15 years, while the US and EU moved away from price support programs, China has increased its reliance of such programs (Anderson et al., 2013; Gale, 2013).

The Chinese government set up these policies in response to the decreasing grain production in the early 2000's. It also increased its support prices steadily after the 2008 food crisis. Generally, these policies contributed to maintaining and increasing domestic agricultural prices and production in China. At the provincial government level, "province governor responsibility system" were created to guarantee regional grain production and storage goals made by the central government. In this context, the Chinese government controls national storage that can be used to stabilize domestic prices and reduce speculation in the agricultural market. At the central government level, the MPP and NPR policies are implemented through state-owned grain enterprises that made loans from specialized "Agricultural Development Bank" in the main producing provinces every year. For wheat and corn, a minimum price policy was made effective by the state purchasing stocks whenever the market price fell below a given price support level. The effects of such programs had two aspects. In the short term, government interventions helped reduce domestic price volatility by releasing public

¹¹ The MPP policy was set up for wheat in 2006, and NPR policy was set up for corn and soybean in 2008. The implementation of the two policies are similar (see Gale (2013) for a review).

stocks during world price spikes. In the long run, the price support levels were chosen to increase slowly over time, generating smooth increases in agricultural prices over the last decade.

During world food spikes, China managed to stabilize domestic prices for wheat and corn. This was made possible in part by restrictive trade policy which insulated domestic markets from international markets (as discussed next). Taking 2008 world food crisis as an example, even though accurate reserve releasing data are not available, the Chinese government started several rounds of sizeable national storage releases to prevent large increases in domestic grain prices (Yang et al., 2008). In the presence of a powerful centralized government, Chinese state-owned enterprises and local grain bureaus control a large amount of the country's grain inventory, allowing them to release stocks on the domestic market at a lower price (instead of selling them abroad to make a profit). These policies worked well for wheat and corn where maintaining self-sufficiency is a policy objective. However, for low self-sufficiency commodities like soybean, China lacked enough national storage to keep market isolated from the price-surgingly world market.

In the long run, Chinese domestic policy managed to steadily increase in wheat and corn prices over the last decade. In contrast with many other market economies, Chinese public food reserve institutions occupy a large part of the nationwide grain storage. For instance, in 2014, the purchasing volume associated with MPP and NPR policies was up to 123.9 million tons, accounting for 34.0% of the Chinese total food

grain purchasing volume¹². Through its MPP and NPR policies, China has had the capacity to release large national stocks to prevent increases in domestic prices for wheat and corn when international prices soared. Similarly, when market prices decreased, the government could escalate domestic prices by slowly raising support prices and increasing public stocks through MPP and NPR policies. Hence, a large national reserve capacity effectively reduced speculative behavior (e.g., hoarding using private storage).

Starting in 2004, the implementation of support price policies allowed China to achieve a steady increase in grain production, thus contributing to attaining its food self-sufficiency objectives. After the 2008 world food crisis, China kept increasing its support prices. It also launched an NPR policy for soybean. Coincidentally, large soybean price bubbles did not develop in China after 2008, likely due to its new public storage policy.

The Role of Trade Policy

China became a member of the World Trade Organization (WTO) in 2001. As a compromise in WTO accession negotiations, China abandoned many agricultural border protection instruments. Currently, the most powerful and effective instruments is the agricultural import quota scheme. China sets annual volume limit on import quota for grain products, but sets no volume limit for food oil products including soybean. The overall grain quota is set within 5% of total annual domestic consumption. Within

¹² Data source: Chinese central government website, available at: http://www.gov.cn/xinwen/2015-01/09/content_2802392.htm. Follow the Chinese statistical tradition, “food grain” includes wheat, rice, corn, beans and tubers in this paper.

the quota, a low tariff of 1% is used, while exceeding the quota, a high tariff of 65% is used. The quota scheme provides a way for China to attain its grain self-sufficiency goal. It also helps stabilize domestic grain prices by controlling import volumes.

However, the trade situation is very different for soybean. Over the last decade, China has imported over 75% of its soybean utilization, meaning that the Chinese soybean market has been supplied mainly by international markets. And the unified low tariff of 3% is used with no import limit for soybean quota. As a result, the Chinese soybean market is not insulated from the international market. This allows international bubbles to be transmitted to the Chinese soybean market. It helps explain our finding that most of the soybean price bubbles are shared between the Chinese market and the international market.

In addition, during the 2008 world food crisis, the Chinese government imposed a series of restrictions and bans on food export, reducing the incentive to export by private grain dealers. As shown in Figure 3, these restrictions included canceling payment of the VAT rebate, suspending export subsidies for staple crops, assessing a tax on fertilizer exports and eventually imposing official bans on all food and feed grain products (Yang, et al. 2008). When the international market prices soared, these policy interventions contributed to isolating domestic grain prices from the international price spikes of 2008. However, this did not apply to soybean. China being a large soybean importer, trade restrictions did not prevent a domestic price surge for soybean at that time. In fact, the opposite occurred. As documented above, the price spike in Chinese soybean market in 2008 lasted longer than the world soybean market.

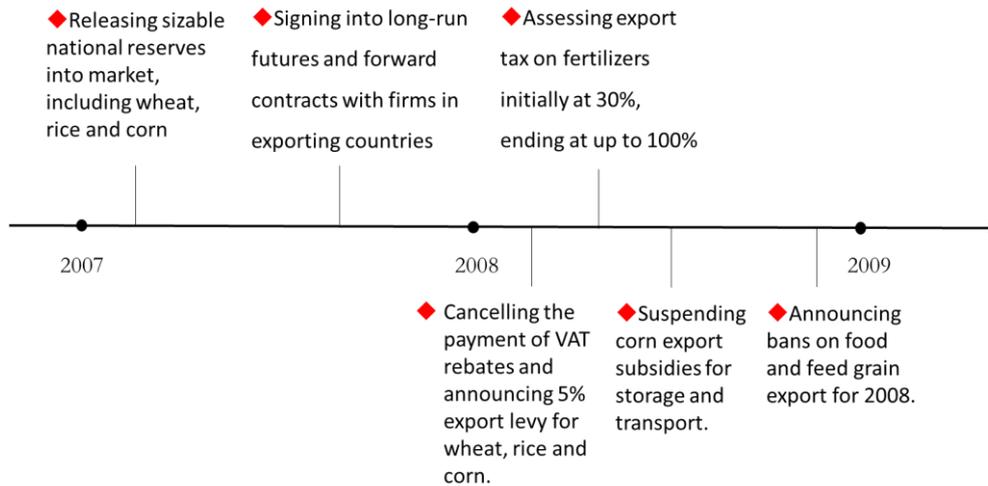


Figure 3. Brief summary of the Chinese short-run domestic and trade restrictions during 2008 world food crisis

Source: Information is collected and reorganized based on Yang, et al. (2008)

In summary, under restrictive trade policy for high self-sufficiency commodities such as wheat, rice and corn, domestic prices are mainly determined by domestic factors. In this context, domestic policies can have large impacts on pricing. This argument applies to the dynamics of Chinese wheat and corn prices, which have been heavily influenced by MPP and NPR government policies. In contrast, in the absence of trade restrictions for low self-sufficiency commodities such as soybeans, domestic prices are affected by the international market, allowing international bubbles to be transmitted to domestic markets.

Interestingly, our empirical results indicate that the Chinese soybean market may amplify international price risk in the world food crisis by the existence of a 228-day bubble in 2008 (which is larger than the corresponding bubble on the world market). On the one hand, with most soybeans being imported, Chinese public stocks were not sufficient to prevent a bubble from developing in the domestic soybean market. In this

case, low domestic stocks, and an inelastic demand contributed to high price volatility and a large bubble in 2008. On the other hand, it is interesting to note that Chinese soybean prices remained high level even after the collapse of the bubble on the world market in 2008. Why was the price bubble in Chinese soybean market larger than the one in the international market in 2008? In a situation of limited government interventions on the soybean market, this larger bubble must be attributed to the behavior of private traders. In other words, our finding of a large bubble for Chinese soybean in 2008 is likely due to poor market intelligence in China. This provides indirect evidence that, at that time, the quality of market information available to Chinese soybean traders was poor.

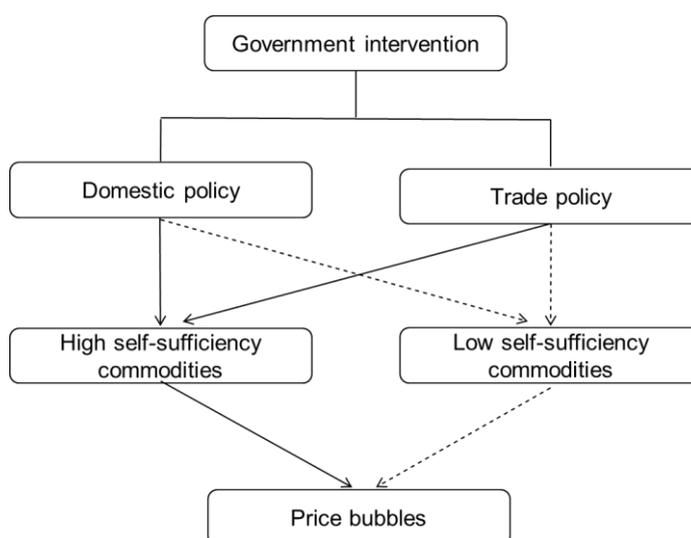


Figure 4. The effect of the government intervention on food price bubbles in China

Note: the solid line represents the major effect on high self-sufficiency commodities; the dashed line represents the minor effect on low self-sufficiency commodities.

In conclusion, over the last decade, China managed to stabilize grain prices by the means of domestic policy and trade policy. This is illustrated in Figure 4, showing

that domestic policy and trade policy can affect prices and, under particular circumstances, stabilize markets and reduce price bubbles. However, such results did not apply to the Chinese soybean market. Indeed, under trade limited government interventions, soybean prices in China were found to be even more prone to instability and bubbles than in the international market during the world food crises. This documents how the behavior of private traders as well as government policies can affect price dynamics. As discussed next, this suggests the presence of possible tradeoffs between the functioning of free markets and government interventions.

CHALLENGES

Our analysis and findings indicate emerging challenges to the stabilization of Chinese agricultural markets. In this section, we discuss possible problems related to Chinese government policies and their sustainability.

Emerging Challenges for Chinese Domestic Policy

During the last 10 years, while international markets exhibited large price volatility, government interventions have helped reduce instability of grain prices on Chinese wheat and corn markets. However, adverse consequences of Chinese agricultural policies are potentially emerging. A current concern is the growing gaps between domestic prices and international prices. Such gaps create two emerging problems regarding the sustainability of current price support policies. First, low import prices and high domestic production costs dramatically increase the incentive of

Chinese farmers to sell their grain to the government. In 2014, the purchasing volume associated with MPP and NPR policies increased by 48.9% from the previous year, reaching 123.9 million tons. In Heilongjiang province, a main agricultural production region, government purchase of food grain increased from 12 million tons, to 18, 33 and 40 million tons from 2011 to 2014¹³. Second, as the gaps between government support prices and international prices grow, the cost of the government support price programs has increased sharply. The governmental grain and oil reserve expenditure boomed from 13.8 billion dollars in 2011 to 24.8 billion dollars in 2014, an increase of 73%. As a percentage of total government expenditures, the cost of the agricultural support price programs rose from 1.6% in 2011 to 2.1% in 2014¹⁴.

These emerging problems in Chinese agricultural market are not an incidental phenomenon. Through history, many support price programs suffered from poorly managed inventory leading to large public stocks and excessive cost (Gouel, 2014). . While such programs can help reduce price volatility and increase farm income, their economic and political sustainability requires that they get implemented at reasonable cost to the taxpayers. In situations where they involved large public stocks, these programs can generate surging cost to the taxpayers. When such scenarios developed, they typically lead to the suspension of these programs. This occurred in 1990's both in the US and the EU. This also happened to the Australia the Wool Reserve Price Scheme which was reasonably successful at stabilizing Australian wool prices through

¹³ Data source: Chinese central government website, available at: http://www.gov.cn/xinwen/2015-02/11/content_2817891.htm

¹⁴ Data are calculated from China's Central Fiscal Budget Table: 2012-2014, Chinese Ministry of Finance. Available at: <http://yss.mof.gov.cn/>.

the 1970's and 1980's. However, after the management right was handed over to the wool industry in 1987, the floor price was dramatically raised, which caused booming supply and large increases in cost, leading to the eventual suspension of the program (Gouel, 2014).

Note that the issue of sustainability of support price programs also applies to India's current agricultural policy (Gupta, 2013). Similar to China, India also tried to stabilize food prices during world price spikes using a Minimum Support Price policy and a Targeted Public Distribution System¹⁵, with both farmers and poor people as intended beneficiaries. For such programs, the issue of proper management of public stocks and their associated cost arise as well. For instance, Indian rice stock increased even during the 2008 world food crisis. This was an unfortunate move. Indeed, from the economics of storage (e.g., Williams and Wright, 1991), we know that increasing (releasing) stocks during a price spike contributes to destabilizing (stabilizing) prices.

Table 4. Brief cross-country comparison of buffer stock-based support price programs

Country	Policy title	Targeted commodity	Policy period	Direct reason of collapse
EU	Target Price and Export Threshold Price	Cereals	1964 - 1995	High export subsidy
Australia	Reserve Price Scheme	Wool	Early 1970's -1991	High floor price
India	Minimum Support Price	Foodgrains	1964 - now	Ongoing program
China	MPP and NPR	Key agricultural commodities	2003 - now	Ongoing program

Source: Information is collected and reorganized based on Grant (1997), Gupta (2013) and Gouel (2014).

The international and historical experience provides some lessons for the

¹⁵ The Targeted Public Distribution System was replaced by the National Food Security Act in 2013, which targets to double the distribution of low-price food grains to cover two third of Indian population.

sustainability of government support price programs and buffer stock policies in agriculture (see Table 4). A common theme is that such programs become unsustainable when public stocks are poorly managed and grow to a point where their cost becomes “excessive”. More specifically, when a part of a buffer stock policy, seeing large increases in public stocks typically means that current support prices are too high and likely unsustainable. In general, public stocks acquired during a bubble must be released to avoid large stock accumulation. Often, the rule governing public stock accumulation is much better defined than the rule governing stock release. This comment applies in general. It also applies to China. Therefore, special attention must be given to balancing stock accumulation and releasing mechanisms in China. This is particularly important when international prices fall below domestic prices. From international experiences, any failure to avoid large public stock buildup would likely lead to the demise of current government programs. The Australian wool example indicates that, even though a price support program helped stabilize prices for several decades, improper management of price support levels and public stock eventually led to its collapse. This stresses the need for balancing national stock accumulation and release mechanisms and price support levels as key components of a sustainable agricultural price stabilization policy for China.

Potential Challenges for Chinese Trade Policy

With 7 percent of the world cultivated land, China faces the challenge of feeding 22 percent of the world population (Lu et al., 2013). Can it be done without relying

extensively on food imports? Emphasizing food security, current Chinese policy tries to attain self-sufficiency for grains (but not for soybean). Over the last ten years, such self-sufficiency goals have been approximately achieved for grains. But is it going to be sustainable? Two factors raise concerns about the sustainability of current agricultural trade policies: 1/ dropping international price; and 2/ surging domestic production cost (see Figure 5).

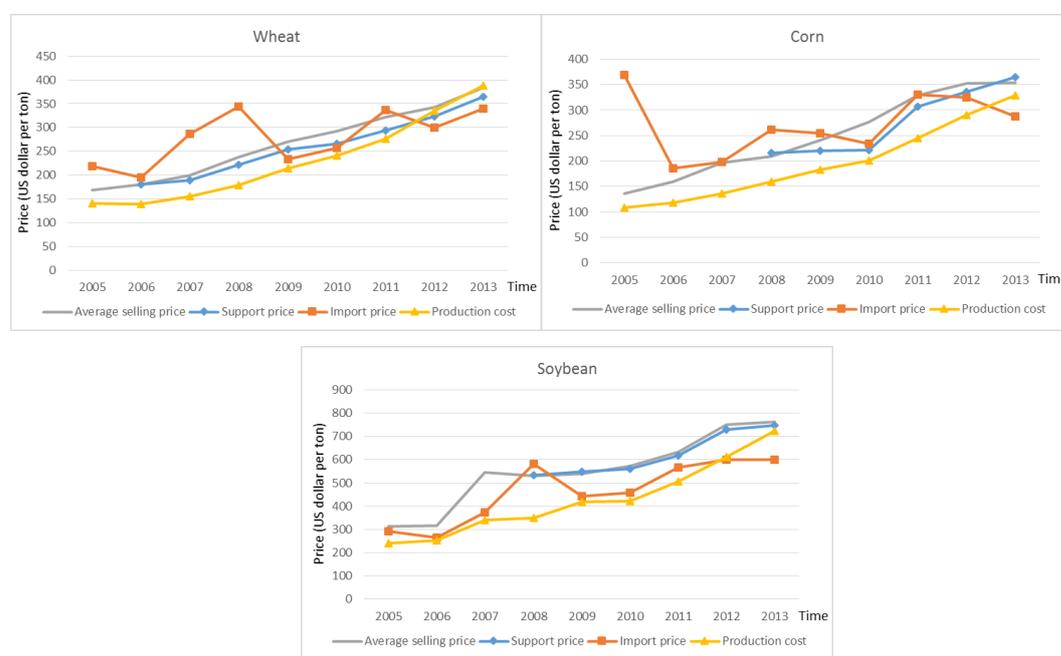


Figure 5. The average selling price, support price, import price and production cost in China: wheat, corn and soybean

Source: the average selling price, production cost and support price are collected from Chinese National Development and Reform Commission, and the import price is calculated by the authors using import volume and import value from Chinese General Administration of Customs.

First, the price difference between the international and Chinese agricultural markets is becoming larger. From the second half of 2012, the international food prices have been dropping, while the Chinese food prices kept increasing. As a result, the current floor prices of major crops including wheat, corn and soybean in China are now

at least 25% higher than international CIF prices (including VAT and duties). Even larger price differences exist in cash crops such as cotton and sugar. Current import volume can be controlled through trade policy and import restrictions. However, there are concerns that the price differences between the international and Chinese markets will keep growing (Chen, 2014).

As compromises in WTO accession negotiation, China abandoned most of its agricultural border protection instruments in 2001. Under WTO rules, growing gaps between domestic and world prices would stimulate food imports and make domestic food markets more integrated with world markets (Brink, 2009). This would also expose domestic markets to international bubbles. As found in the soybean market, there are some questions about the quality of market intelligence and the ability of domestic markets to handle increased instability. Indeed, the large bubble that developed in the Chinese soybean market in 2008 set an alarm for the Chinese government. On the one hand, there are concerns about relying on international markets in the presence of a worldwide food crisis. On the other hand, imposing a restrictive trade policy could become inconsistent with WTO rules, making current trade policy unsustainable.

Second, Chinese agricultural production costs have increased dramatically in the last decade. Official census shows that the ratio of total production cost and the average selling price of wheat, corn and soybean escalated from 83.1%, 80.4% and 76.9%

in 2005, to 101.4%, 92.9%, and 94.9% in 2013, respectively¹⁶. In other words, even though support price programs were established for grain, the net farm returns from food production have been shrinking over the last 10 years (see Figure 5). If this trend continues, farm production cost would exceed average selling price, inducing a decrease in food production on marginal land. In turn, this would make it more difficult for China to attain food self-sufficiency goals.

Moreover, the surging cost comes mainly from labor cost, which is foreseen to keep increasing with the development of Chinese economy. From 2005 to 2013, the Chinese agricultural labor cost of wheat, corn and soybean production surged from 224.1, 271.6 and 149.3 US dollar per hectare, to 838.8, 1111.1, and 490.3 US dollar per hectare, respectively¹⁷. Even though agricultural productivity has been increased dramatically in China, production cost and labor cost have been increasing faster than farm productivity gains in the last 10 years. Increasing production cost has two effects: enlarging price difference between the international market and Chinese market; and lowering the stimulus effect of support price policies. Hence, the surging cost of labor is likely to create significant challenges to Chinese agricultural and trade policy.

In conclusion, emerging problems in China raise questions about current agricultural domestic and trade policies. High public stocks and surging import incentives may challenge the sustainability of these Chinese policies. As discussed by

¹⁶ Data are calculated from National Agricultural Product Cost and Return Survey conducted annually by the Chinese National Development and Reform Commission.

¹⁷ Data are calculated from National Agricultural Product Cost and Return Survey conducted annually by the Chinese National Development and Reform Commission.

Newbery and Stiglitz (1981) and Chavas et al. (2014), finding a proper balance between government policy and free markets in the management of food and food security issues will remain challenging. The case of China is no exception.

CONCLUSION

This paper studies price differences between international and Chinese food markets from the perspective of price bubbles. The analysis compares Chinese markets versus international markets, with a focus on wheat, corn and soybean over the last ten years. It documents differences that exist between the international and Chinese markets. The paper finds that price bubbles occurred more frequently in the international market than in the Chinese market for wheat and corn. But for soybean, the Chinese market exhibited larger bubbles than the international market in 2008 world food crisis. These results were obtained using bubble days, bubble periods, bubble length and deviation rate during bubble period. Our findings give useful insights on the factors contributing to differences in price dynamics both across markets and across commodities. Understanding the nature and sustainability of different food price trajectories in large consuming countries like China helps better assess the world food balance and agricultural trade patterns.

For high self-sufficiency commodities (wheat and corn), our analysis points to the role of Chinese government policies. We argued that both domestic policy (including support price programs) and trade policy (including import restrictions) contributed to stabilizing Chinese grain markets in a period of more unstable world

markets. Thus, over the last decade, we find that Chinese government interventions isolated domestic grain markets and helped reduce price bubbles on these markets. Our paper discusses the effectiveness of current policies. It also raises some concerns that current Chinese policies may not be sustainable, creating significant challenges to policy makers.

Our results for Chinese low self-sufficiency commodities (soybean) are very different. The Chinese soybean market has seen a more limited role of government. In this context, we interpret the large bubbles found on the Chinese soybean market as evidence of poor market intelligence by market traders in China. This raises questions about the ability of markets in emerging economies to deal effectively with shocks and instability.

Our analysis has relied on the recent developments in the econometrics of testing for bubbles, with a focus on testing for unit roots. This provides useful insights on the dynamics of conditional mean prices. It would be useful to expand the investigation to explore how bubbles relate to the dynamics of the (conditional) price distribution. This appears to be a good topic for future research. In addition, our empirical analysis has focused on two regions and three agricultural commodities. There is a need to extend the analysis of price dynamics in other regions. This would help obtain additional insights on the functioning of markets and their interactions with government policies. Applied to agricultural markets, this should provide useful information about the determinants of food price volatility, with implications for the design and implementation of food security policy.

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