Fluctuation and Cycle of Pork Price in China

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Abstracts: By using Census x12 Seasonal Adjustment Method and Hodrick-Prescott Filter Method, Frequency (band-pass) Filter Method, it was found that there are obvious and regular seasonal feature in the fluctuation of pork price in China; Unexpected event or contingency shocks affect pork price significantly; Over the long-term view, pork price displays a rising trend; Pork price fluctuation approximately experienced 3 complete cycles from Jan, 1996 to May, 2009. The length of the cycles is between 37 and 49 months, and the average length is 42.33 months.

Key words: Pork Price fluctuation; Seasonal Adjustment; HP, BP Filter Method

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I. Introduction

The hog industry is a major part of China's animal husbandry, which accounts for more than 64% of China's total meat. It is not only the important source for farmers' income, but also the most significant source of animal protein. China's pork price fluctuated since hog market reform in 1985. But it was unusually soaring up dramatically and fell down sharply in a short period resent years. It begun to rise up from 15.86RMB/kg on May 2007, and reached 26 RMB/kg in February 2008, the historical peak in China, and which was almost 74 percent growth comparing with that of the last year. And then it declined to 15.68 RMB/kg on May 2009. It damaged consumer's welfare when price rising and producer's benefit when price falling. It is essential to understand the pork price cycle and determine the reason.

Empirical study on agricultural products was carried about most early by Moore, who studied the fluctuation cycle of agricultural products with Difference Method. And he found that there was certain cyclical fluctuation in price of agricultural products. Then Schultz, Tinbergen, and Ricci (1930) separately put forward CobWeb Model in studying the fluctuation of agricultural products' price. Based on that, Kaldor (1934) and Ezekiel (1938) used Deferred Model to analyze the influence of price to next cycle. As to the fluctuation of price, Chinese scholars generally use statistical methods and Difference Method. Residue Method (Xiong Wen), Seasonal Adjustment and Long-term Trend Separation Method are adopted in studying non-seasonal fluctuation cycle (Ke Bingsheng, 1994). Jiang Naihua (1998) identified the short-term and long-term fluctuation with trend rejection method, and analyzed the structural feature of fluctuation in grain production using variance decomposition. Cheng Jie and Wu Laping measured the price cycle of main products using H-P Filter Method. Shu Guang and Qiao Guanghua (2008) analyzed the fluctuation cycle of pork price with spectral analysis. Detailed moreover quantitative measurement and analysis

on the fluctuation of pork price is rare and the methods used are limited in some way.

II. Fluctuation Features of Pork Price Based on Seasonal Adjustment Model

A. Methodology

Quarterly and monthly observed data of time series always shows monthly or quarterly cyclical fluctuation. The seasonal change often covers the real characters of the fluctuation. Therefore, we need to make the seasonal adjustment to the time series data before carrying on the measurement analysis. As the data this paper used is monthly pork retail price from January, 1996 to May, 2009, seasonal adjustment is also needed.

There are four popular methods for seasonal adjustment: Census X12 Method, X11 Method, Moving Average Methods and Tramo/Seats Method.

Compared with X11 Method, Census X12 Method has some advantages: (1) Extensive time series modeling and model selection capabilities for linear regression models with ARIMA errors; (2) Wide variety of seasonal and trend filter options;(3) Diagnostics of the quality and stability of the adjustments achieved under the options selected.

The biggest differences lies in the seasonal factors are different in different years when using Moving Average Methods and Census X12 Method. As Tramo/Seats Method is used for estimating and forecasting regression model with missing data, we finally choose Census X12 Method, and use the Additive Model.

In order to dissociate the monthly data series Y_t into Trend and Cycle item TC_t, Season item S_t and Irregular item I_t, three steps should be followed:

① Initial estimate of Seasonal Adjustment

Calculate the initial result of Trend and Cycle item with 12 centralization moving average

$$TC_t^{(1)} = \left(\frac{1}{2} Y_{t-6} + Y_{t-5} + \cdots + Y_t + \cdots + Y_{t+5} + \frac{1}{2} Y_{t+6} \right) / 12$$

Calculate the initial estimate of SI

$$SI_t^{(1)} = Y_t - TC_t^{(1)}$$

Calculate the initial estimate of Season Factor S with 3×3 moving average

$$\hat{S}_t^{(1)} = \left(SI_{t-24}^{(1)} + 2SI_{t-12}^{(1)} + 3SI_t^{(1)} + 2SI_{t+12}^{(1)} + SI_{t+24}^{(1)} \right) / 9$$

Eliminate the remaining tendency in the Season Factor

$$S_t^{(1)} = \hat{S}_t^{(1)} - \left(\hat{S}_{t-6}^{(1)} + 2\hat{S}_{t-5}^{(1)} + \cdots + 2\hat{S}_{t+5}^{(1)} + \hat{S}_{t+6}^{(1)} \right) / 24$$

Initial estimate of Seasonal Adjustment will be

$$TCI_t^{(1)} = Y_t - S_t^{(1)}$$

② Calculate the tentative Trend and Cycle Factor and ultimate Season Factor

Calculate the tentative Trend and Cycle Factor with Henderson moving average

$$TC_t^{(2)} = \sum_{j=-H}^{H} h_j^{(2H+1)} TCI_{t+j}^{(1)}$$

Calculate the tentative SI

$$SI_t^{(2)} = Y_t - TC_t^{(2)}$$

Calculate the tentative Season Factor with 3×5 moving average

$$\hat{S}_t^{(2)} = \left(SI_{t-36}^{(2)} + 2SI_{t-24}^{(2)} + 3SI_{t-12}^{(2)} + 3SI_t^{(2)} + 3SI_{t+12}^{(2)} + 2SI_{t+24}^{(2)} + SI_{t+36}^{(2)} \right) / 15$$

Calculate the ultimate Season Factor

$$S_t^{(2)} = \hat{S}_t^{(2)} - \left(\hat{S}_{t-6}^{(2)} + 2\hat{S}_{t-5}^{(2)} + \cdots + 2\hat{S}_{t+5}^{(2)} + \hat{S}_{t+6}^{(2)} \right) / 24$$

Second estimate of seasonal adjustment

$$TCI_t^{(2)} = Y_t - S_t^{(2)}$$

③ Calculate the ultimate TC_t and I_t

Calculate the ultimate Trend and Cycle Factor with Henderson moving average

$$TC_t^{(3)} = \sum_{J=-H}^{H} h_j^{(2H+1)} TCI_{t+j}^{(2)}$$

Calculate the ultimate I_t

$$I_t^{(3)} = TCI_t^{(2)} - TC_t^{(3)}$$

B. Seasonal Adjustment of Pork Price in China

This paper is based on the monthly pork price from Jan., 1996 to May, 2009 data[1] with Eviews6, the seasonal adjustment results are as follows：

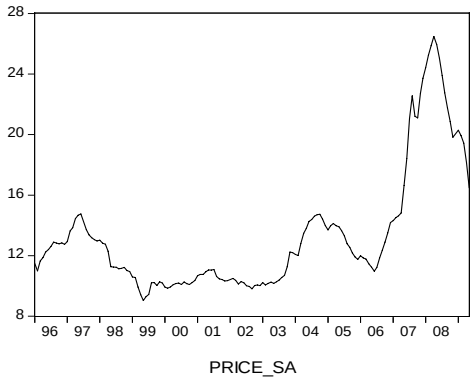

Figure 1 Seasonal Adjustment series

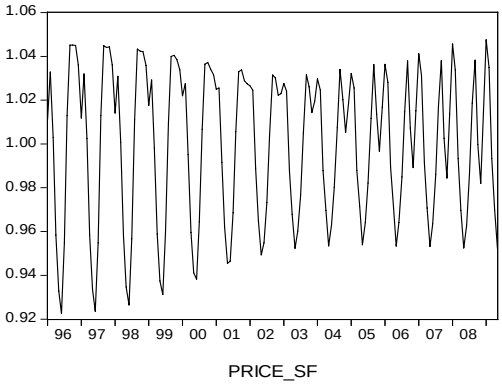

Figure 2 Season Factor series

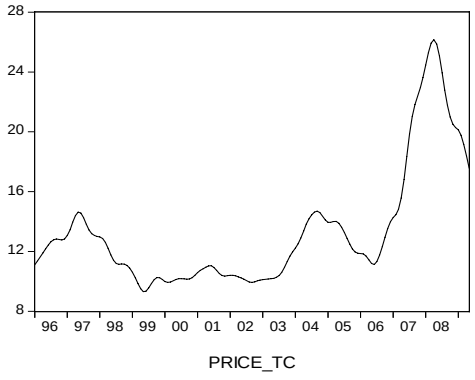

Figure 3 Trend and Cycle Factor series

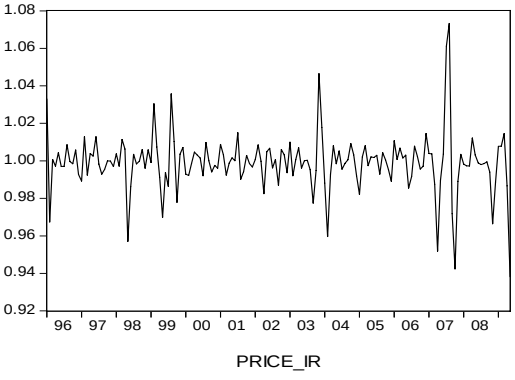

Figure 4 Irregular Factor series

[1]Data source: National Animal Husbandry and Veterinary Station.

C. Analysis

Seasonal fluctuation is significant from Figure 2. That is, in one year, the pork price changes follow up this path: the pork price is high in January and reaches the highest level in February, then it begins to fall in March and down to the lowest in June and sometimes in July, after then, it keeps increasing and reach the second peak in October.

The Seasonal fluctuation is closely related with the meat consumption patterns. With high temperature and more vegetables since May, pork consumption decreases, consequently pork price falls; while after August, the weather turns cold together with several traditional festivals, such as Moon holiday in October and Spring Festival in February, the meat demand increases and pork price climbs up. Limited with Eviews6, Chinese holiday effect can not eliminate.

From the Irregular Factor series, we can see that there’re fierce irregular fluctuations in 1998-1999, 2003-2004, 2007, 2008-2009. This indicates that unexpected event or contingency shocks occurred in these periods. Take the latest three shocks as example. In early 2003, the SARS epidemic situation caused the sudden drop of pork demand. As the markets were insulated and blocked, hog sale was badly influenced. Most sellers sold hogs at low prices and reduced the livestock scale. But after that, when tourism and catering industry revived, the demand to pork increased sharply. Especially till the bird flu in 2004, pork, as the main substitute of poultry meat, its consumption grew in large scale. Consequently, the price soared (Figure 4).

Similarly, in late 2006, the eruption of pig blue otopathy epidemic situation resulted in the longest fluctuation since 1990s. As the epidemic situation spread, sow and piglet died in batches. Many breed households decreased the breeding scale and the supply of pork cut short, which ultimately resulted in the continuous increase of pork price lately.

In 2008, continued with the influence of otopathy epidemic, the government

increased the subsidy to pig breeding which enlarged the supply dramatically in the following months, and pork price began to fall back. Together with the economic crisis, pork price came to further decline even in October, 2008, and when it came to April and May, 2009 the Swine Influenza led to the psychological misunderstanding to pork which made the price fall back to the level in May, 2007, the negative effect of this shock is the fiercest one since 1996.

Compared the adjusted pork price series with the initial price series, we can see that the former is more smooth. The seasonal adjustment may help to identify the fluctuation cycle specially chain growth rate and features the like.

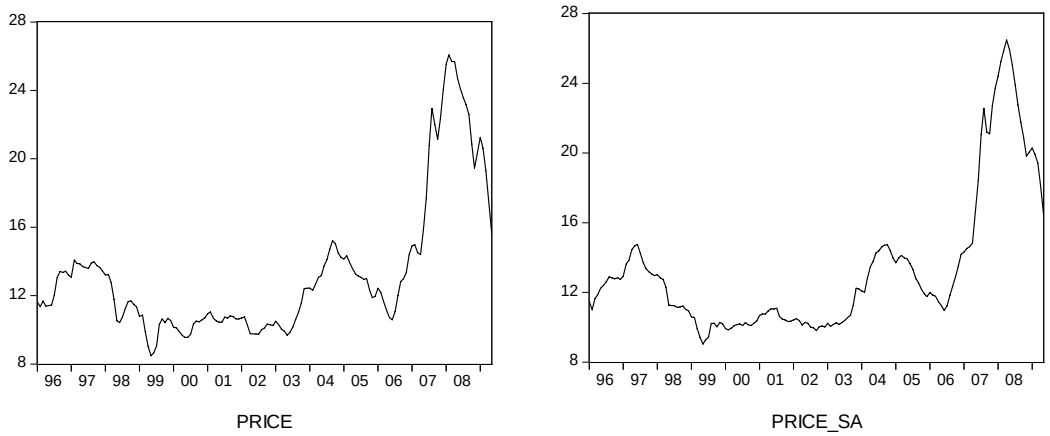

Figure 5 Comparison between price series and seasonal adjusted series

Finally, Figure 3 displays the trend and cycle series which is achieved after eliminated the seasonal and irregular effect. It's clear that the pork price increased a lot from January, 1996 to May, 2009. But trend and cycle effect still haven't been separated yet. Seasonal adjustment can't solve this problem, in order to gain the separate trend and cycle fluctuation, Hodrick-Prescott Filter Method and Band-Pass Filter Method will be adopted.

III. Cycle Measurement and Analysis based on H-P and B-P Filter Model

A. Methodology

When separating the trend and cycle factor and measuring the cycle length after seasonal adjustment, the Hodrick-Prescott Filter Method and Band-Pass Filter Method are the most popular ways.

(1) Hodrick-Prescott Filter Method

Suppose $\{Y_t\}$ is a time series including trend and cycle factors, $\{Y_t^T\}$ is the trend factor and $\{Y_t^C\}$ is the cycle factor, then,

$$Y_t = Y_t^T + Y_t^C \qquad t=1, 2, T$$

To calculate the H-P Filter is to separate Y_t^T from $\{Y_t\}$, generally, the problem can be transited to reach the minimum of the loss function:

$$\min\left\{\sum_{t=1}^{T}\left(Y_t - Y_t^T\right)^2 + \lambda\sum_{t=1}^{T}\left[\left(Y_{t+1}^T - Y_{t-1}^T\right) - \left(Y_t^T - Y_{t-1}^T\right)\right]^2\right\}$$

When analyzing monthly data, λ=14400 (brought forward by Hodrick and Prescott in 1998) is widely accepted.

(2) B-P Filter Method

First, design a Low-Pass Filter, suppose the fittest formula is:

$$B(L) = \sum_{h=-\infty}^{\infty} B_h L^h$$

while, $B_h = \frac{1}{2\pi}\int_{-\pi}^{\pi}\beta(\omega)e^{i\omega h}d\omega$

Choose the suitable weight a_h to reach the minimum of the formula:

$$\min \frac{1}{2\pi}\int_{-\pi}^{\pi}\left|\beta(\omega)-a_k(\omega)\right|^2 d\omega$$

while, $\beta(\omega)=\begin{Bmatrix}1,\ for\left|\omega\right|\le\bar{\omega}\\0,\ for\left|\omega\right|\succ\bar{\omega}\end{Bmatrix}$, $a_k(\omega)=\sum_{h=-k}^{k}a_h e^{-i\omega h}$

Then, we can get the approximately best Low-Pass filter $LP_k(p)$. Similarly, formulate the High-Pass filter $HP_k(p)$ to filter the fluctuation factor with low frequency. Obviously,

$$HP_\infty(p)=1-LP_k(p)$$

Then formulate the B-P filter $BP_k(p,q)$, when analyzing monthly data, p=6, q=32, k=12 (brought forward by Baxter and King in 1999) is widely accepted.

B. Measurement of Cycle

(1) Hodrick-Prescott Filter Method

Analyzing the PRICE_TC series with Hodrick-Prescott Filter Method and measuring the cycle, we get result in Figure 6:

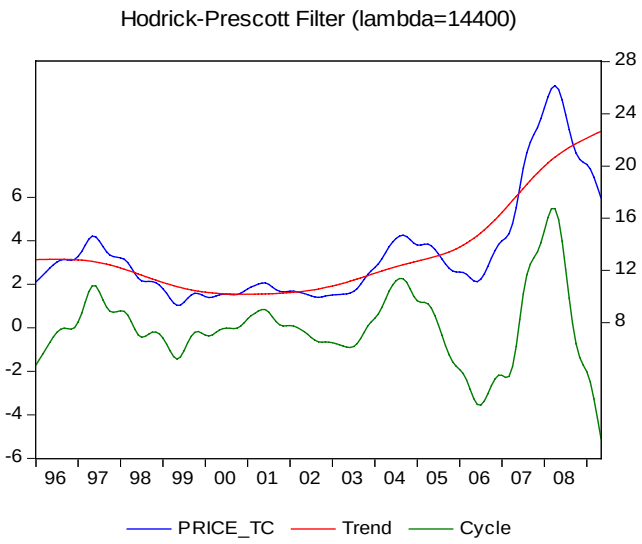

Figure 6 Hodrick-Prescott Filter Analysis on the Price_TC series

As showed in Figure 6, PRICE_TC curve is just the trend and cycle curve, Trend

curve displays the long-term tendency of the pork price, and Cycle curve is the very curve we need after eliminating the seasonal, tendency and irregular factor. Cycle curve distinctly shows the cycles that pork price follows: There are four cycles from 1996.1-2009.5. The first cycle is dated from 1996.1 to 1999.5, with 41 months; the second is 1999.6-2003.6, 49 months included; the third is 2003.7-2006.7, 37 months in total; and the fourth is 2006.8-2009.5. According to the data constraint, the fourth cycle is maybe not a complete cycle. In brief, the pork price experienced three complete cycles since 1996.1, and the average length is approximately 42.33 months. The fluctuation scope is similar to each other between the first and third cycle, while the second cycle is relatively smooth and the fourth one is fair turbulent.

(2) B-P Filter Method

First, use the BK fixed-length symmetry B-P filter $BP_{36}(18,96)$, that is, when the truncation point is 36 months, B-P filter can accept cycle between 18 and 96 months. Because of the truncation point, the first 36 months and the last 36 months are truncated. Outcomes are shown in Figure 7:

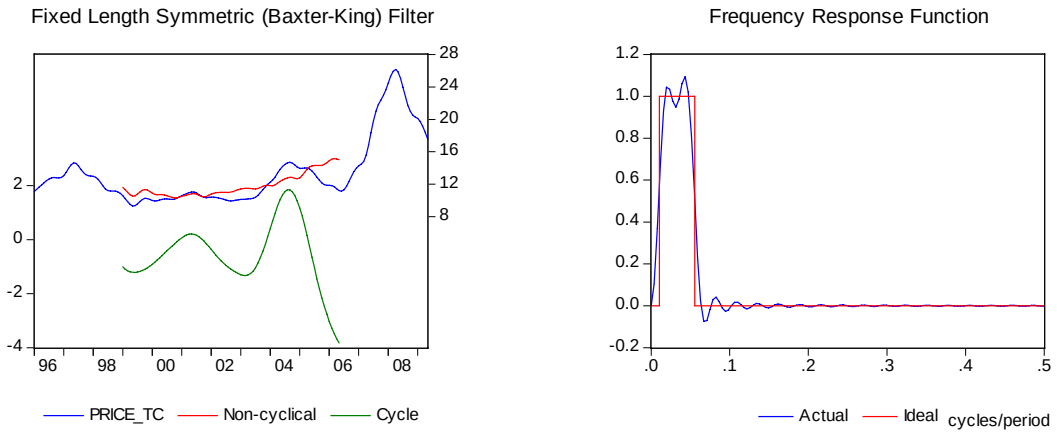

Figure 7 B-P Filter Analysis on the Price_TC series (BK)

The left chart describes the separation of the Price_TC series, the Cycle curve is what we need and the Non-cyclical curve is the gaps between the actual value and the cycle series. Without the first 36 months and the last 36 months, there are two distinct cycles, one is dated from 1999.6 to 2003.3, totally 46 months; the other is from

2003.4 to 2006.5, 38 months in total. As the truncation point influences, the second cycle may be an uncompleted one. The right chart in Figure 7 shows the frequency respond function $w(\omega)$, and ω falls in [0, 0.5]. From this chart, the difference between the actual and ideal value is acceptable, that is, the parameter in B-P model is suitable.

Next try the asymmetry total samples B-P filter to analyze the Price_TC series for sake of avoiding the influence of truncated data. Results are in Figure 8:

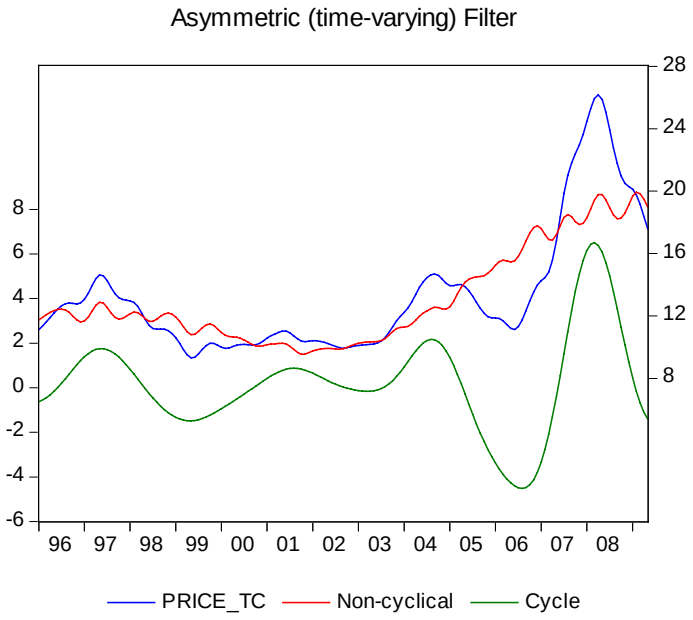

Figure 8 B-P Filter Analysis on the Price_TC series(ASCF)

Compare Figure 8 with Figure 7, Figure 8 contains all samples, and we can see there are approximately four cycles: the first is from 1996.1-1999.5, 41months included; the second is 1999.6.-2003.6, 49 months in all; the third is 2003.7-2006.7, 37 months in all; and the last is 2006.8-2009.5, only 34 months. Also because of the data constraints, the fourth cycle may be an uncompleted one.

To sum up, the outcome of Hodrick-Prescott Filter Method and B-P Filter Method (ASCF) goes all the way, while B-P Filter Method (BK) differs in some way. That is resulted from the truncation point maybe.

Ⅳ. Conclusion

According to the analysis above, some conclusions can be drawn:

Firstly, the fluctuation of pork price in China displays obvious and regular seasonal feature. Monthly price in May-June annually is the lowest point of the year, but in January- February and October- December price keeps at a high level. The monthly price presents a tendency like “V” pattern. The producers can manage to meet the high price for good return by their own decision-making and more pork can be imported from the international market by macro trading policy to meet the demands.

Secondly, unexpected event or contingency shocks make dramatic change in pork price and then damage consumer’s welfare and producer’s income in China. The occurrence and the spread of animal epidemic disease, which can cause large reduction in quantity of sows and the piglets, may be the main reason of price shake in later period. However the government policies encouraged hog production last year push more capital shifting into hog sector and farmers enlarged production size, and the unusual growth in pork production exceed the domestic demand. Therefore, policy may be one factor to cause the price falling. Lowest subsidy price is needed when price is too low for hog farmers to cover their cost, and subsidy to the entire sow need to improve, especially when price is going up.

Thirdly, over the long term, pork price in China appears a rising trend reflect the increasing hog production cast due to high price of feed, labor and energy, which also fits with the growth and improvement of socio-economic development level and people’s living standards.

Finally, pork price in China approximately experienced three complete cycles from 1996.1 to 2009.5. The cyclical length lies in 37-49 months; the average length is about 42.33 months. The fluctuation scope is similar between the first and third cycle, while the second cycle is relatively smooth and the fourth one is fair turbulent. It is in the falling trend now and may experienced long time in low price. But for most

farmers, the hog price is almost break even point, if hog and pock price continuously declines, hog farmers will get loss again. It is urgent to make polices to protest hog farmers' income.

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