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RESEARCH ARTICLE

Nonlinear dynamics of pork price in China

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Abstract

This paper primarily analyzes the evolution path of China's pork price by employing the threshold autoregression model (TAR). Considering the unit root test with a threshold effect and heteroskedasticity of the TAR model, we show that the pork price series is a unit root process in each regime, and the heteroskedasticity in the TAR model greatly affects the results of linearity test. We find that the changing process of pork price has two regimes: mild regime and expansion regime. In particular, a change belongs to an expansion regime if it is larger than 0.5881; otherwise, it falls in the mild regime.

Keywords: pork price, heteroskedasticity, TAR unit root

1. Introduction

Hog industry plays a pivotal role in China's economic system, not only because pork is among the most important sources of food in China, but also due to the fact that the changes in pork price significantly affect China's consumer price index (CPI), which eventually influence the national macroeconomic policy.

Even today, the Engel Index in China (share of expenditure on food in total household expenditure) is still as high as 35%. Among all the sources of food, meat is definitely a crucial one. The meat prices have a substantial influence on the CPI. Fig. 1 indicates that pork price had a higher volatility than other meat and food products did. It has been documented that pork accounts for a large proportion of meat (more than 60%), so that the pork's weight could be more than 6% in the calculation of the CPI (Yu and Abler 2014). There is a significant correlation between pork price and the CPI, and the correlation coefficient is as large as 0.82. Therefore, the volatility of pork price may affect the size of the CPI to a substantial extent.

Fig. 2 indicates that there were three large price cycles or spikes in China's pork prices from January 2000 to March 2014. To be more specific, it shows that: (1) The first spike occurred in the period from 2003 to 2006, with pork price increasing from 9.76 CNY kg^{-1} in May 2003 to 15.13 CNY kg^{-1} in September 2004 and then decreasing to 10.58 CNY kg^{-1} in June 2006; (2) the second spike appeared from 2007 to 2009, with pork price increasing from 14.39 CNY kg^{-1} in April 2007 to 26.08 CNY kg^{-1} in February 2008 rapidly and then decreasing to 15.46 CNY kg^{-1} in June 2009; (3) the third spike happened from 2010 to 2012, with pork price increasing from 16.04 CNY kg^{-1} in June 2010 to 30.35 CNY kg^{-1} in September 2011 and then decreasing to 22.61 CNY kg^{-1} in July 2012 (according to the China Animal Agriculture Association (CAAA), CNY kg^{-1}). The three price spikes brought a lot of uncertainties to producers; meanwhile, they caused welfare loss for consumers. Chinese government carried out a series of policies to stabilize the prices, such as various subsidies on hog farmers, which further distorted

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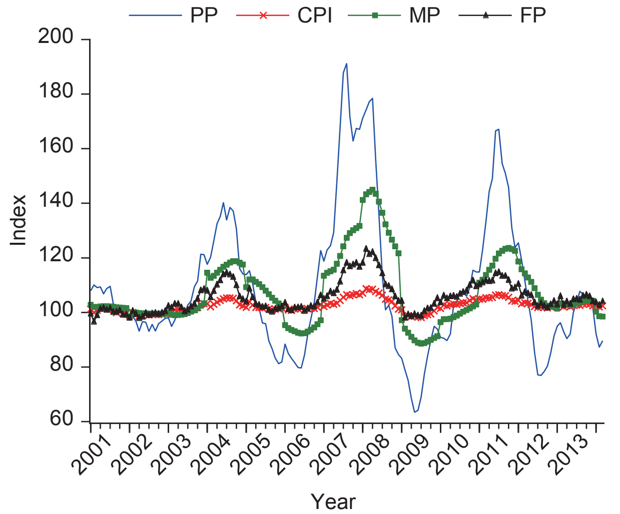

Fig. 1 Index of pork, meat, food and consumer price, 2001–2014. PP, pork price; CPI, consumer price index; MP, meat price; FP, food price. The data are from China Animal Agriculture Association (CAAA) and National Bureau of Statistics of China (NBSC).

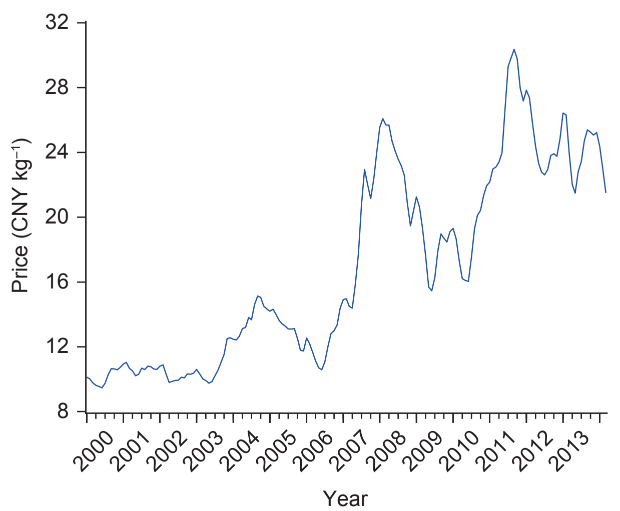

Fig. 2 Price of pork, 2000–2014. The data are from CAAA database.

the price system, and increased price volatility in contrast.

Given the important policy implications, a lot of researches have shed light on analyses of pork price. Some previous studies pay attention to the causes of the volatilities of hog and pork prices (Xin and Tan 1999; Li and He 2007; Xu 2008), and recent literatures are mainly focused on whether or not the price transmission and adjustment is asymmetric in the pork market. On the one hand, several studies use the asymmetric error correction model (AECM) to deal with the problem. Yu and Zheng (2013) suggest that there is an asymmetry in the pork price transmission. On the other hand, some others use threshold autoregression model (TAR) to analyze the asymmetry of pork price. For instance, Hu and Wang (2010) find that there is a nonlinear adjustment mechanism in China's pork price index. Yang and Xu (2011) conclude that both hog price and pork price are sensitive to bad news in China. Wang *et al.* (2014) also find the asymmetric transfer of hog price and pork price. In addition, Luo and Liu (2011) indicate that there is no significant asymmetry of volatility based on threshold autoregressive conditional heteroskedasticity (TARCH) model or exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model, while Feng (2013) obtains an opposite conclusion based on the same method for China's pork market with different sample period.

Although the nonlinear smooth transition characteristics of pork price have been intensively discussed by previous studies, few of them consider the effect of heteroskedasticity in empirical studies. As the sampling distributions are quite sensitive to conditional heteroskedasticity in the errors, modeling the conditional variance more carefully is necessary for accurate inference on the conditional mean (Hansen 1997). The unit root tests, such as the ADF test, have low power if there is a threshold effect. However, the empirical studies of pork prices fail to pay enough attention to these issues. Considering a unit root test with a threshold effect and heteroskedasticity of the TAR model, this paper gives a further empirical analysis about the path of China's pork price. The empirical results suggest that if the heteroskedasticity of the TAR model is ignored, the path of China's pork price may have incorrect regimes. Further, the path of China's pork price has a significant threshold effect so that it can be divided into an expansion regime and a mild regime, which will be defined later.

The organization of this paper is as follows. In section 2, the frame of TAR model is discussed, it includes the model estimation and testing method associated with the number of regimes, and then reports an application to China's pork price data. The estimate results and some discussions are given in sections 3 and 4, respectively. The final section concludes.

2. Data and methods

2.1. SETAR(2) and SETAR(3)

TAR models can capture the nonlinear characteristics of the system and use the space of threshold to improve the accuracy of the linear approximation (Tsay 1989, 2002; Tong 1990; Chan 1993; Hansen 1996, 1997). A TAR (m) model takes the form

$$Y_t=\alpha_1^T X_{t-1} I_{1t}(\gamma, d)+\ldots+\alpha_m^T X_{t-1} I_{mt}(\gamma, d)+u_t \quad (1)$$

Where, Y_t is a univariate time series and $X_{t-1}=(1\ Y_{t-1}\ Y_{t-2}\cdots Y_{t-s})^T$ is a $k\times1$ vector with $k=1+s$; the parameters α_i is a $k\times1$