

A Dynamic Analysis of Influencing Factors in Price Fluctuation of Live Pigs --- Based on Statistical Data in Sichuan Province, China

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Abstract

Based on the weekly price data about supervision on the “early warning system of live pig production in Sichuan Province”, this article made a dynamic analysis in the research objects of live pig price, corn price, piglet price and pork retail price, including cointegration relationship test, Granger causality test and impulse response analysis so as to analyze the long term and short term conduction effects among different variables within the system of live pig system. It was discovered from the cointegration analysis that, the conintegration relationship existed within the live pig price system in Sichuan Province. In the long run, influence of piglet price on price fluctuation of live pig price was greater than that of corn price. The opposite is true to the short run. It was discovered through Granger test that, within a single production cycle (4 to 6 months), the piglet price, corn price and pork price affected the live pig price under Granger significance, while corn price and piglet price were exogenous to the system. It was discovered through the impulse response analysis that within a single production cycle, impact of the live pig price on price fluctuation of piglet manifested a “positive-negative-positive” response, mostly a “negative” response on price fluctuation of pork and mostly a “positive” response on price fluctuation of corn price. Finally, the authors put forward suggestions of decomposition of interest of the live pig industrial chain and escalation of value, etc.

Keywords: live pigs, price, fluctuation, conduction

1. Introduction

Ever since 1985 when the government cancelled purchase of live pigs by state quotas, lifted the control over the market of purchase and sales and carried out multi-channel operation, the price of live pigs presented a periodical fluctuation condition under the influences of the market supply and demand rule and other elements. As the primary meat consumer goods of urban and rural residents, if the price of pork continued to fluctuate drastically, not only the interests of producers and consumers might be seriously damaged, but also the total stability of all material prices and the pre-production and post-production industries might be affected through the conduction mechanism, which further might affect the entire live pig industrial chain (Han Yijie, 2011). It was found from the literature review that, study on the price fluctuation of live pigs had always been a hot issue for discussion of scholars both at home and abroad. Existing studies mainly focus on formation mechanism of imbalance of supply of and demand on live pigs, fluctuation characteristics, conduction mechanism, risk warning and precautionary measures, etc. This article mainly studied causes for periodical fluctuation of live pig price and conduction of the price.

Since Hanau (1927) and Coase & Fowler (1935) detected periodicity in the industry of live pigs for the first time and Ricci (1930), Schultz (1930) and Tinbergen (1930) proposed the theoretical explanation of periodical fluctuation of live pig price, some academics have applied this theory to make a discussion on price fluctuation of live pigs at different time slots in different areas (Carsten Holst, 2011). In China, some scholars (Peng Tao, 2009) referred to the analysis framework of cobweb model and discovered that price fluctuation of live pigs were manifested in the two forms of normal fluctuation and abnormal fluctuation. Abnormal fluctuation was a bottleneck that impeded healthy and orderly development of the live pig industry. Generally speaking, causes for price fluctuation of live pigs can be generalized as the following several ones, namely, change of production cycle, low industrial concentration, influence of epidemic situation, change of production costs, change of consumer demand, deficiency of guidance of rational policies and shortage of a set of good risk avoidance mechanism and value discovery tool, etc. (Sun Liangyuan, 2001; Li Binglong, 2009). Under the influences of all the above factors, such a vicious and strange circle was caused in the live pig industry in China as “difficulty in

selling live pigs – decline in price – slaughter of sows – reduction of live pigs – short supply – rise in price – increase in livestock breeding – difficulty in selling live pigs” (Zhang Xiaotong, 2010).

Due to the biological characteristics of live pigs, the supply condition of live pigs in the market may not be immediately responded in terms of output and there was a hysteresis effect. In order to make clear this process, it is necessary to make an analysis in the conduction mechanism of price fluctuation of live pig. Xiao Liuyi (2005) discovered through his study that the factors that affected the process of price conduction of live pig industry contained production costs, elasticity of demand, market structure, substitutability and anticipation of the market, etc. On that basis, some scholars began with several major prices within the live pig system and studied the conduction relationship between them. For instance, based on the national monthly data analysis between 2002 and 2006, Wang Fang (2009) discovered that a Granger causality relationship existed between the piglet price, corn price and live pig price. Zhang Lixiang (2011) found through his study that a long term cointegration relationship existed between the prices of different links in the industrial chain of live pig. Price of piglet was the Granger cause for the price of live pig, price of pork and price of feed and price of live pig was the Granger cause for the price fluctuation of feed and pork.

There are still a lot of literature concerning about price fluctuation of live pig, and this article only made a general review. A general survey of the above research achievements and a deep analysis in causes for periodical fluctuation and conduction mechanism of live pig price offered important enlightenment for the article. Nonetheless, there are also some disadvantages in the existing studies. There were few studies about guidance or conduction among several prices within the live pig system in analysis of price fluctuation of live pig by relevant scholars. In terms of property of the data, most of existing studies used annual data to make an analysis and monthly data were seldom employed. There was no literature analyzing price fluctuation of live pig with weekly data, the specific reason might be related with frequency of existing supervision and statistics. In the opinion of the authors, since the influencing factors of live pig price were complicated and the fluctuation of the price was frequent, it was of great value and importance to conduct a study on the short-term fluctuation. Based on this, this article attempted to make a dynamic analysis in the influencing factors for price fluctuation of live pig with weekly data. The basic research framework of this article goes as follows. The first part is the introduction, which introduces the background for writing this paper, makes a review of existing literature and finds out the entry point for study in this article. The second part is a dynamic analysis and mainly analyzes the long term and short term guidance and conduction relationship between several kinds of prices within the live pig price system based on the weekly price data in supervision of the “early warning system of live pig production in Sichuan Province”. The third part is research conclusion and policy enlightenment.

2. A Dynamic Analysis of Price Fluctuation of Live Pigs in Sichuan Province

In order to supervise and analyze information about production, epidemic situation, price and other aspects of live pigs in due course and in a comprehensive, scientific and systematic way, deliver early warning report at regular time to farms (farmers) and warn them to reasonably arrange production of live pigs, Sichuan initiated the first early warning system for production of live pigs in the whole country in May 2008. This system mainly focused on price of piglet, price of reserve sow, retail price of pork, price of corn, price of wheat bran and mixtures of fattening pigs. By November 2011, this system had supervised data for 184 weeks in 42 months and currently, the system runs in an ideal and smooth way. Since there are numerous influencing factors for price of live pig, by referring to previous research achievements, this article mainly discussed the influences of the four kinds of prices of piglet, reserve sow, retail price of pork and corn. Anticipated influencing direction of all variables is shown in Table 1.

Table 1. Selection of variables and anticipated influencing direction

Influencing factors	Name of variables	Anticipated influencing direction
Price of live pig	Y	
Price of piglet	X ₁	+
Price of reserve sow	X ₂	+
Retail price of pork	X ₃	+
Price of corn	X ₄	+

2.1 Cointegration Analysis of Price Fluctuation of Live Pig

2.1.1 Unit Root Test of Variables

Prior to cointegration test, it is necessary to make a test on stability of all variables so as to avoid “spurious regression” caused by usage of unstable data fitting model. A common method to test the stability of a sequence is unit root test. Considering any possible heteroscedasticity in the initial data, all related models employed the logarithm sequence of the initial data for analysis. We used Eviews6.0 to conduct the unit root test on the four

kinds of price variables and got the result in Table 2. From Table 2, it can be found that, all the time series data of the four kinds of data were I(1) sequence, satisfying the antecedent for cointegration test.

Table 2. Unit root test result of all variables

Variables	ADF statistic	(c, t, p)	5% critical value	Conclusion
LY	-2.166	(c, t, 2)	-3.435	Unstable
LX ₁	-0.179	(0, 0, 1)	-1.943	Unstable
LX ₂	-1.968	(c, t, 2)	-3.438	Unstable
LX ₃	-2.282	(c, t, 1)	-3.435	Unstable
LX ₄	-2.490	(c, t, 1)	-3.435	Unstable
ΔLY	-4.975	(0, 0, 1)	-1.943	Stable
ΔLX ₁	-4.634	(0, 0, 1)	-1.943	Stable
ΔLX ₂	-5.852	(0, 0, 1)	-1.943	Stable
ΔLX ₃	-5.111	(0, 0, 1)	-1.943	Stable
ΔLX ₄	-6.276	(c, 0, 1)	-2.877	Stable

Note: (1) c is a constant term, t is a trend term and k is the lag order; (2) selection standard of the lag phase p is based on the norm of minimum value of AIC and SIC; (3) Δ means the first-order difference of variables

2.1.2 Cointegration Relationship Test

2.1.2.1 Cointegration Test

If all the K sequences of Y, X₁, X₂, ..., X_k were first-order single sequences, we may set up a regression equation (Gao Tiemei, 2009). Eviews6.0 was employed to process the data and the regression estimation result was shown in Equation (1):

$$Y = -1.8635 + 0.0631X_1 - 0.0011X_2 + 0.6981X_3 + 0.0839X_4 + u_t \quad (1)$$

(-5.54) (5.10) (-3.29) (57.03) (0.74.2)

$\bar{R}^2 = 99.41\%$ $F = 7769.89 (P = 0.00)$ $D.W = 0.34$

From the estimation result, we may find that, the goodness of fitting the model was high and the entire effect passed the test. Nevertheless, the value of D.W was low and was discovered to $< d_L$ in the test, indicating that Equation (1) had serious positive sequence correlation. This article employed the generalized difference method to correct the value and got the result as in Equation (2). As a result of collineation, the price of reserve sow X₂ was rejected that was not significant in t test.

$$LLY = -0.1475 + 0.1143LLX_1 + 0.9836LLX_3 + 0.0781X_4 + u_t \quad (2)$$

(-2.27) (3.41) (22.76) (1.93)

$\bar{R}^2 = 95.30\%$ $F = 924.93 (P = 0.00)$ $D.W = 1.89$

Unit root test was conducted to residual error in Equation (2) and we may get the residual sequence u_t from the estimation result of the regression equation. A unit root test was conducted to u_t , (not including the constant and time trend, and lag order was determined by AIC norm) and the t statistic of ADF was -9.4598 (p:0.0000). By referring to the critical value by MacKinnon (1991), the null hypothesis was rejected at the significance levels of 1%, 5% and 10%. Thus, we can confirm that u_t was a stable sequence (namely, $u_t \sim I(0)$), and a cointegration relationship existed between the four variables.

$$u_t = LLY - 0.1475 - 0.1143LLX_1 - 0.9836LLX_3 - 0.0781X_4 \quad (3)$$

From Equation (2), it can be found that, in the long run, piglet price, retail price of pork and corn price all exerted a positive influence on slaughter pig price, and furthermore, influence of pork price was greater than influence of piglet price, which was even greater than the influence of corn price.

2.1.2.2 Vector Error Correction Model

The cointegration equation merely indicated that long term equilibrium relationship existed between the variables and in order to make clear the conduction direction between different variables in the short term fluctuation, we had to establish a VECM Model (Vector Error Correction Model). According to the result of cointegration test, we may describe the VECM Model of the live pig price system as in the following Equation (4). The lag phase was chosen 2 when the reciprocals of the characteristic roots of the equation all fell within the unit circle, indicating that the equation was stable.

$$\begin{aligned} \Delta LY = & -0.0221ecm_t + 0.4434\Delta LY(-1) + 0.0338\Delta LY(-2) + 0.0250\Delta LX_1(-1) \\ & (0.0098) \quad (0.1262) \quad (0.1239) \quad (0.0701) \\ & -0.01199\Delta LX_1(-2) + 0.3966\Delta LX_3(-1) - 0.1052\Delta LX_3(-2) - 0.2619\Delta LX_4(-1) \\ & (0.0678) \quad (0.1277) \quad (0.1292) \quad (0.1829) \\ & + 0.0644\Delta LX_4(-2) \\ & (0.1830) \end{aligned} \quad (4)$$

It can be found from Equation (4) that when the lag phase was one to two weeks, pork price still had the largest influence upon slaughter pig price. Yet, the corn price at that time had a greater influence on slaughter pig price than piglet price. In the Vector Error Correction Model, the coefficient of the error correction item was negative, complying with reverse correction mechanism. As far as a single production cycle is concerned (four to six months), this article would conduct a test in the following Granger causality test and impulse response analysis to determine the influences of piglet price, corn price and pork price on slaughter pig price.

2.2 Granger Causality of Price Fluctuation of Live Pig

Based on the framework of VAR Model (Vector Autoregression Model), this article employed first-order difference sequence to conduct a Granger causality test. Considering an analysis of the conduction relations between several prices within the live pig system, this article employed the principle with combination of AIC and SIC minimum information norm and debugging phase by phase in selection of the lag phase. It was discovered that when one phase was lagged, pork price had Granger causality for price of live pig. However, it was not until 16 phases were lagged that the piglet price began to Granger cause the price of live pig. When the lag phase was selected 20, all these three prices Granger caused the price of live pig. The test results in the three lag phases were shown in Table 3.

It can be found from Table 3 that, when the lag phase was one, the price of live pig affected respectively price of piglet, price of pork and price of corn under Granger significance. When the lag phase was 16 and 20, the price of piglet and price of corn were exogenous to the system. That is to say, they were not affected by other variables, indicating that short term effect should be taken into more consideration in analyzing the influences of price fluctuation of piglet and corn. In the meantime, slaughter pig price and piglet price affected the price of pork under Granger significance, but the influence of corn price was not significant.

Table 3. Granger causality test result of all variables

Independent variables	Null hypothesis	χ^2	Degree of freedom	Conclusion
ΔLY equation	ΔLX_1 can not Granger cause ΔLY	0.04	1	Not refused
	ΔLX_3 can not Granger cause ΔLY	9.18***	1	Refused
	ΔLX_4 can not Granger cause ΔLY	0.74	1	Not refused
	ΔLY can not Granger cause ΔLX_1	12.06***	1	Refused
ΔLX_1 equation	ΔLX_3 can not Granger cause ΔLX_1	0.04	1	Not refused
	ΔLX_4 can not Granger cause ΔLX_1	2.21	1	Not refused
	ΔLY can not Granger cause ΔLX_3	15.47***	1	Refused
ΔLX_3 equation	ΔLX_1 can not Granger cause ΔLX_3	1.70	1	Not refused
	ΔLX_4 can not Granger cause ΔLX_3	1.16	1	Not refused
	ΔLY can not Granger cause ΔLX_4	2.85*	1	Refused
ΔLX_4 equation	ΔLX_1 can not Granger cause ΔLX_4	0.26	1	Not refused
	ΔLX_3 can not Granger cause ΔLX_4	0.21	1	Not refused
	ΔLX_1 can not Granger cause ΔLY	35.26***	16	Refused
ΔLY equation	ΔLX_3 can not Granger cause ΔLY	33.51***	16	Refused
	ΔLX_4 can not Granger cause ΔLY	13.74	16	Not refused
	ΔLY can not Granger cause ΔLX_1	17.66	16	Not refused
ΔLX_1 equation	ΔLX_3 can not Granger cause ΔLX_1	11.11	16	Not refused
	ΔLX_4 can not Granger cause ΔLX_1	11.27	16	Not refused
	ΔLY can not Granger cause ΔLX_3	27.62**	16	Refused
ΔLX_3 equation	ΔLX_1 can not Granger cause ΔLX_3	37.01***	16	Refused
	ΔLX_4 can not Granger cause ΔLX_3	9.20	16	Not refused
	ΔLY can not Granger cause ΔLX_4	10.85	16	Not refused
ΔLX_4 equation	ΔLX_1 can not Granger cause ΔLX_4	18.14	16	Not refused
	ΔLX_3 can not Granger cause ΔLX_4	6.47	16	Not refused
	ΔLX_1 can not Granger cause ΔLY	50.01***	20	Refused
ΔLY equation	ΔLX_3 can not Granger cause ΔLY	42.57***	20	Refused
	ΔLX_4 can not Granger cause ΔLY	31.40**	20	Refused
	ΔLY can not Granger cause ΔLX_1	27.64	20	Not refused
ΔLX_1 equation	ΔLX_3 can not Granger cause ΔLX_1	17.34	20	Not refused
	ΔLX_4 can not Granger cause ΔLX_1	19.91	20	Not refused
	ΔLY can not Granger cause ΔLX_3	48.06***	20	Refused
ΔLX_3 equation	ΔLX_1 can not Granger cause ΔLX_3	64.63***	20	Refused
	ΔLX_4 can not Granger cause ΔLX_3	27.05	20	Not refused
	ΔLY can not Granger cause ΔLX_4	12.23	20	Not refused
ΔLX_4 equation	ΔLX_1 can not Granger cause ΔLX_4	22.79	20	Not refused
	ΔLX_3 can not Granger cause ΔLX_4	11.97	20	Not refused

Note: *, ** and *** respectively indicate significance at the levels of 10%, 5% and 1%.

2.3 Impulse Response Analysis of Price Fluctuation of Live Pig

Based on cointegration analysis and Granger causality test, we may roughly measure the long term equilibrium relationship and short term fluctuation effect of several prices within the live pig price system. Nevertheless, these two methods failed to offer more information about the dynamic characteristics in the case when one variable acted on another variable and introduction of impulse response function helped to resolve this issue. Based on VAR Model (lagging 20 phases), this article employed the generalized impulse method that did not depend on the orthogonal matrix of the disturbance term in the sequence of the variables and set up an impulse response function about price fluctuation of live pig and its impact on price of piglet, price of pork and price of corn.

From Figure 1, it can be found that, the price of live pig attained a maximum positive response (8% or so) at the beginning of the phase in response to impact of piglet price. Afterwards, this response began to decrease progressively and changed to a negative one at the fifth phase. From the sixth phase to the twentieth phase, impact of unit standard of piglet price on price of live pig had an obvious driving effect and this result was almost consistent with the analysis in the previous part of the article. Later, this impact began to decline and then slowly began to rise and tend to smoothness. Considering a single production cycle of live pig (four to six months, and similarly hereinafter), impact of price fluctuation of piglet made the price of live pig present a “positive-negative-positive” response.

From Figure 2, it can be found that response of live pig price in its response to a standard deviation impact of pork price was relatively sensitive and was a positive one (10% or so). Afterwards, this response began to decline and began to switch to negative from the fourth phase to the nineteenth phase. The response began to rise slowly in the forthcoming phases and then gradually tended to stability. This indicated that, within the production cycle of live pig, influence of pork price on price of live pig was mostly negative, which was inconsistent with what had been anticipated. For any possible underlying reason, the authors held the opinion that in the current market with asymmetric information, too high price of pigs might stimulate producers to blindly expand their breeding scale, which may further disturb equilibrium of supply and demand of the market and lead to decline in price of the forthcoming cycle. In addition, it might be caused by control of the government over price of pork. When the price of pork was too high, the government would promulgate relevant policies or distribute reserve pork to attain a balance between supply and demand so as to prevent too high pork price.

From Figure 3, it can be found that, the response of live pig price at the beginning of the phase in response to impact of corn price was negative. However, this negative response began to switch to positive from the second phase to the fourth phase. Then, the response was shocked on a small margin, attained its maximum between the tenth phase and the twelfth phase, began to gradually decline later and tended to stability. This result was almost consistent with analysis in the previous part of the article. Considering a single production cycle of live pig, influence of price fluctuation of corn on price of live pig was mostly positive, which was consistent with the reality.

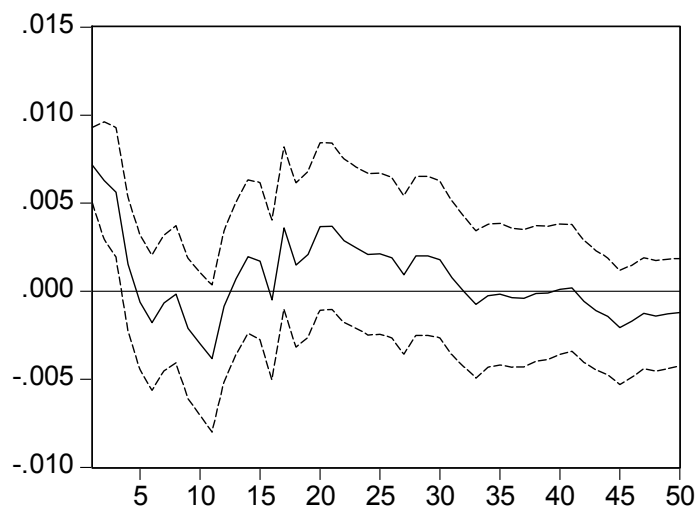


Figure 1. Response of one unit standard deviation of piglet price fluctuation (ΔLX_1) impact to price fluctuation of live pig

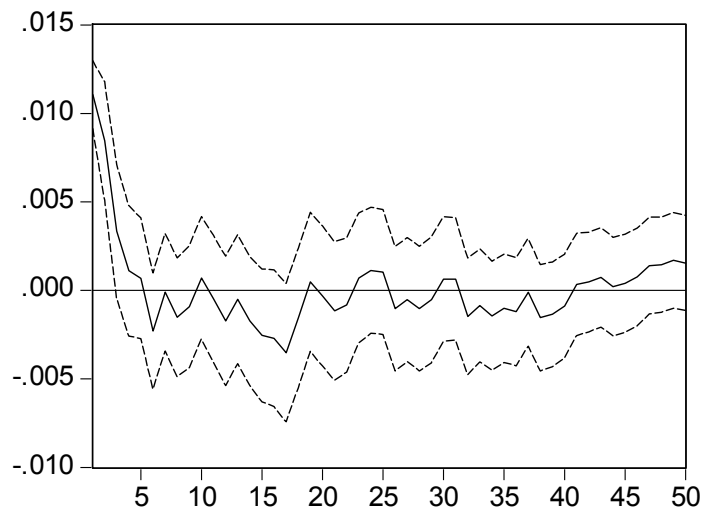


Figure 2. Response of one unit standard deviation of pork price fluctuation (ΔLX_3) impact to price fluctuation of live pig

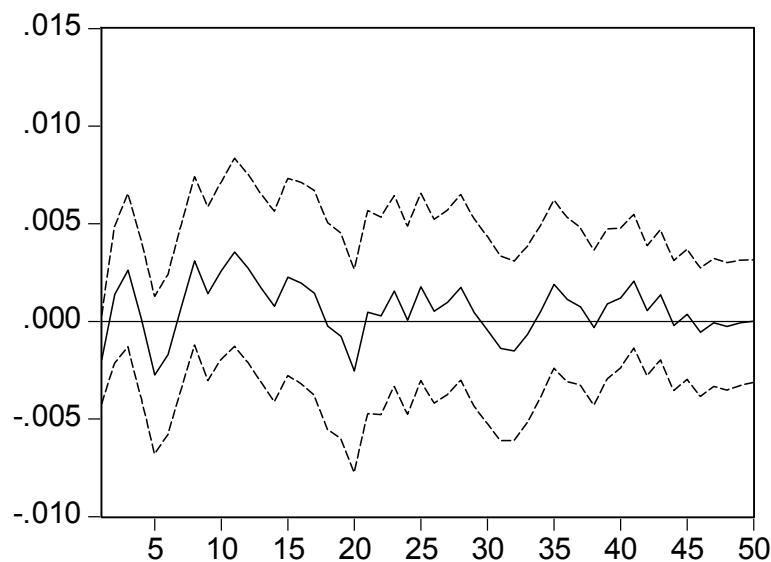


Figure 3. Response of one unit standard deviation of corn price fluctuation (ΔLX_4) impact to price fluctuation of live pig

3. Major Conclusions and Policy Enlightenment

Firstly, it was found out in the cointegration analysis that a long term cointegration relationship existed within the live pig price system, which was the same with the conclusion of monthly data analysis, but there were something different in terms of the degree of conduction among all the variables. In the long run, influence of price fluctuation of piglet on price fluctuation of live pig was greater than its influence on the price fluctuation of corn. The reason might be that the government had gradually improved its grain reserves system and reduced the fluctuation range of the price of grain. In the short run (when the lag period was one to two weeks), the price of pork still had the greatest influence on the price of slaughter price, while influence of corn price on the price of slaughter pig was greater than the influence of piglet price.

Secondly, it was found in the Granger causality test that within a single production cycle (four to six months), piglet price, corn price and pork price affected the price of live pig under the Granger significance and live pig price and piglet price affected the price of pork price under the Granger significance, which was basically consistent with the monthly data analysis. In addition, it should be noted that, the piglet price and corn price were exogenous to the system. That is to say, they were not affected by other variables, indicating that analysis

of influences of price fluctuation of piglet and corn should take more consideration of the short term effect.

Thirdly, it was found in the impulse response analysis that, within a single production cycle, impact of price fluctuation of piglet made the price of live pig manifest a “positive-negative-positive” response. Impact of price fluctuation of pork mostly had a negative effect on the price of live pig, whereas impact of price fluctuation of corn mostly had a positive effect on the price of live pig. This result was basically consistent with the monthly data analysis, but part of characteristics were still open for subsequent test.

Based on the above research conclusions, this article put forward two policy suggestions:

Firstly, it is necessary to continue to improve the market early warning mechanism and precaution any abnormal fluctuation. According to the industrial characteristics of the live pig industry, it is necessary to strengthen supervision on piglet, corn and pork, make perfect price expectation, take measures in time and alleviate influences of abnormal fluctuation of pig price.

Secondly, it is necessary to intensify attention to the supply chain of live pigs, especially the smoothness of the supply chain, price fluctuation degree in the process of conduction and decomposition and escalation of value interest, so as to discuss conductivity of regional price fluctuation and interest distribution of the supply chain.

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